1990-1991

PUBLICAT

VEGETABLE Production Recommendations

Ministry of Agriculture and Food

Ontario

90-06881/

To the best of the collective knowledge of the members of the Ontario Crop Protection Committee, all pesticides listed in this publication were federally registered, reviewed by the Ontario Pesticides Advisory Committee and classified by the Ministry of the Environment as of November 8, 1989.

The information presented on the pesticide container label regarding application rates and methods of application is the final authority and where conflicts occur between this publication and the container label, the latter applies.

PAY CLOSE ATTENTION TO ALL INSTRUCTIONS AND WARNINGS PRINTED ON THE PESTICIDE LABEL.

The Ministry of Agriculture and Food, or the Ontario Crop Protection Committee by printing this publication does not offer any warranty or guarantee and they do not assume any liability for any crop loss, animal loss, health, safety or environmental hazard caused by the use of a pesticide mentioned in this publication.

POLICY STATEMENT

In this Publication, most recommendations list several pesticides that are effective for each insect or disease discussed. Where possible, the less hazardous materials and those that growers have used satisfactorily for a number of years are listed first. These are followed by the more toxic pesticides and/or newer ones with which we have less experience. It must be emphasized that, in some cases, the most effective pesticides are highly toxic.

Weather and other factors influence the effectiveness of pesticides and the likelihood of plant injury by control chemicals. Consult the package label and other information regarding compatibility with other materials, the effect of high or low temperatures, poor drying conditions, etc. Wettable or soluble powders (WP or SP) generally are less likely to cause plant injury than liquid concentrates (EC, SC, and F).

A number of brand names of pesticides are given in the calendars as a convenience to the grower and are neither an endorsement of the product nor a suggestion that similar products are not effective.

The pesticide recommendations are reviewed annually by the Ontario Crop Protection Committee. For additional information or clarification of recommendations, contact Ontario Ministry of Agriculture and Food personnel. **OLD EDITIONS SHOULD BE DISCARDED** Health and Welfare Canada has established maximum residue limits (MRL's) for pesticides. However, growers should be aware that processors or retailers may demand different pesticide limits. Growers should seek advice of their intended market as to which restrictions or limitations are applicable.

FEDERAL REGISTRATION AND PROVINCIAL CLASSIFICATION

Ontario's Pesticides Act and Regulation 751, administered by the Ministry of the Environment, prohibits the sale and use of pesticide products unless they are registered under the federal Pest Control Products Act and classified under the provincial Pesticides Act by being placed in one of six schedules of the Ontario regulation.

FEDERAL REGISTRATION

There are three categories:

1. **Full Registration**
   Implies that all federal departments involved in the registration process agreed that the data package was acceptable at the time of registration.
2. **Temporary Registration**
   Indicates that there is a need for additional scientific or technical information to acquire a full registration. Temporary registrations expire on the 31st of December each year and the products must be re-registered if they are to be available for use in the following year.
3. **Temporary Registration (Restricted Class)**
   Indicates that there is an urgent need for the pesticide but that studies on the safety of the product are incomplete. Such registrations expire on the 31st of December each year and the products must be re-registered if they are to be available for use the following year.

PROVINCIAL CLASSIFICATION

Pesticide products are classified into six schedules in Regulation 751 on the basis of their toxicity, environmental or health hazard, persistence of the active ingredient or its metabolites, concentration and usage. This classification system provides the basis for regulating the distribution, availability and use of pesticide products in Ontario.

For updated information on the regulatory status of these or other pesticides contact the Agriculture & Industrial Chemicals, Section. Hazardous Contaminants Coordination Branch, Ministry of the Environment, Toronto. Telephone (416) 323-5095.

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PESTICIDE RESISTANCE

Many of the pesticides recommended have a very specific mechanism of action; that is, they act on a single system or site in the organism. These materials **should not be used continuously and repeatedly** in a season-long program, since this will increase the chances of the development of pest resistance. Examples of these types of compounds are Benlate, Lannate, the pyrethroids (Ambush, Belmark, Pounce), etc.

In our recommendations we suggest that such compounds be used **in combination with other pesticides or that they be alternated with other pesticides** so that the likelihood of resistance development is reduced.

It should be noted that several pesticides may act similarly. Thus, parathion and Guthion, for example, act on the same site, and if resistance develops to one, it is likely to also apply to the other (this is called cross-resistance). Thus, alternating these compounds will not be useful. Rather, they should be alternated with insecticides with different modes of action: for example, Thiodan.

ONTARIO MINISTRY OF AGRICULTURE AND FOOD

HORTICULTURAL CROP ADVISORS

Area Served or Specialty	Name	Address	Phone No.
Eastern Ontario	Deb Hoffman	College of Agricultural Technology Kemptville, K0G 1J0	613-258-8359
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Essex	Leslie Huffman	Research Station, Harrow N0R 1G0	519-738-2251
Marketing	Bob Cobbledick	Vineland Station L0R 2E0	416-562-4147
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Greenhouse Crops	Wayne Brown	Vineland Station L0R 2E0	416-562-4141
Essex	Clem Fisher	Research Station, Harrow N0R 1G0	519-738-2251
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PEST MANAGEMENT SPECIALISTS

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Essex, Kent	Todd Leuty	Research Station, Harrow N0R 1G0	519-738-2251
Provincial Plant Pathologist	Craig Hunter	P.O. Box 587, Simcoe N3Y 4N5	519-426-7120

Agri-phone Numbers — for regularly up-dated recorded messages: 1-800-263-2194

Kingsville	519-733-3151	Ancaster	416-527-9117	Newmarket	416-775-3493
London	519-438-1014	Vineland	416-562-4345	Bowmanville	416-623-4944
Woodstock	519-537-7161	St. Catharines	416-687-6611 416-687-6612	Smithfield	613-392-3422
Simcoe	519-426-7810 (veg.) 519-426-9664 (fruit)	Georgian Bay	519-599-2915	Kemptville	613-258-5836

PESTICIDES-CONTROL FIELD OFFICES

ONTARIO MINISTRY OF THE ENVIRONMENT

COUNTRY	DISTRICT	TELEPHONE
Essex, Kent, Lambton	H.E. Collins P.O. Box 726, 435 Grand Ave. W. Chatham, Ontario N7M 5L1	519-354-2150
Elgin, Middlesex, Oxford	D.C. Morrow/W. Lampman 985 Adelaide St. S. London, Ontario N6E 1V3	519-661-2200
Haldimand, Norfolk, Niagara, Hamilton, Wentworth, Dufferin, Wellington, Waterloo, Brant	P. McCubbin/R. Miller Ontario Government Building 119 King St. W. Hamilton, Ontario L8N 3Z9	416-521-7640
Bruce, Grey, Huron, Perth	B.T. Lobb Ont. Min. of Agr. & Food Bldg. 20 King St., Box 688 Clinton, Ontario N0M 1L0	519-482-3428
Halton, Peel, York, Durham, Toronto, Simcoe, Muskoka	J. Richardson/H. Ploeg/ C. Zubovits 7 Overlea Blvd., 4th floor Toronto, Ontario M4H 1A8	416-424-3000
Peterborough, Victoria, Haliburton, Northumberland	A.G. Carpentier 139 George St. N. Peterborough, Ontario K9J 3G6	705-743-2972
Frontenac, Hastings, Lennox & Addington, Prince Edward, Leeds & Grenville	D.A. Raddon, M. Ferguson 133 Dalton Ave., Box 820 Kingston, Ontario K7L 4X6	613-549-4000
Prescott & Russell, Renfrew, Stormont, Dundas & Glengarry, Ottawa-Carleton, Lanark	R.P. Cameron 2378 Holly Lane, Suite 204 Ottawa, Ontario K1V 7P1	613-521-3450
Manitoulin, Nipissing, Parry Sound, Sudbury, Cochrane, Timiskaming, Algoma	T. Spires/J. Negusanti 199 Larch Street Sudbury, Ontario P3E 5P9	705-675-4501
Kenora, Rainy River, Thunder Bay	G.R. Gammond Ontario Government Buildings 435 James St. S. Thunder Bay, "F", Ontario P7C 5G6	807-475-1215
Head Office Hazardous Contaminants Co-ordination Branch	Pesticides Section Hazardous Contaminants Co-ordination Branch 135 St. Clair Ave. W., Suite 100 Toronto, Ontario M4V 1P5	416-323-5095
Pesticide Licencing & Examination Section	Environmental Approvals Branch 250 Davisville Ave., 3rd Floor Toronto, Ontario M4S 1H2	416-440-3713

PUBLICATIONS — The following publications are available from any of the Pesticide Control Field offices or from Pesticides Section, Suite 100, Ministry of the Environment, 135 St. Clair Ave. W., Toronto, Ontario M4V 1P5:

— Personal Protective Equipment for Pesticide Users
— Chemical Safety Handbook
— Pesticides Act and Regulations
— Chemical Storage Signs

PRECAUTIONS WITH ALL PESTICIDES

Read this entire section before using any pesticides.

GENERAL PRECAUTIONS

1. Always read the label before opening pesticide containers, and follow all precautions and directions. Before starting, keep a record of the common names of all pesticides handled and especially those listed as hazardous in this publication. This list should be known by members of your family in the event of an accident.
2. Use an anti-backflow device, to prevent back siphoning, when drawing water from wells, ponds, streams and other sources of water. Mix pesticide into the tank with sprayer at least 50 m from the water source. Triple or pressure rinse the empty container and add rinse water to tank. Only mix enough solution to do the spray job. After loading and mixing, wash down gloves and boots with clean water before removing.
3. Never smoke, chew tobacco or eat while handling or applying pesticides. Do not carry tobacco or food items in clothes worn while spraying. Change clothing and wash before eating.
4. When handling and mixing pesticide concentrates, rinsing empty containers or repairing leaks, a full set of protective clothing should be worn, including waterproof cap, coveralls, impervious gloves and boots and eye protectors. If highly or extremely toxic pesticides are being used, a repirator should be worn. If very dusty formulations are being handled, a dust mask should be used. If volatiles or gases are being handled, a respirator must be worn. If these gases are highly dangerous or used in an enclosed space, a self-contained breathing apparatus may be needed.
5. During application, a tractor cab with charcoal filter gives adequate protection against exposure. Impervious gloves, boots, coveralls and cap should be worn when tending to stoppages. When using airblast and mist blowers and tractors without cabs, waterproof suits including caps and impervious gloves and boots should be worn. When applying fumigants in the field, a respirator should be available for problems with equipment or if the fumigant is not adequately sealed in the soil and escapes.
6. When the spray operation is complete, bath or shower after spraying to remove pesticide deposits on the skin. Avoid handling anything in the home before bathing.
7. Well, pond and surface water may be contaminated by pesticides. Every effort should be made to avoid this from happening. For more details, see **OMAF Factsheets, Management of Pesticides on the Farm, Agdex 607, Guide to Handling and Applying Herbicide to Protect Water Supplies and Reduce Personal Exposure, Agdex 607.** It is an offence to contaminate surface waters with pesticides. To prevent this from occurring:
   - Keep pesticide concentrates above flood plain in a locked storage.
   - After emptying, triple or pressure rinse, crush and dispose of containers.
   - Mix concentrate and water at least 50 m away from any water supply.
   - Use appropriate buffer zones and berms to avoid surface water contamination of wells, ponds and streams.
   - If possible, do not use drinking water sources to fill spray equipment.
   - Do not spray within 10 m of shallow wells or 5-10 m of other water supplies under ideal conditions and farther away if there is any air movement. Stop spraying when wind velocity reaches 10 km/hr.
   - There are government programs to protect your water supply and assist in building pesticide storage facilities.

IF ACCIDENTS OCCUR

1. If an accident occurs, remove contaminated clothing including underclothes immediately, and wash contaminated skin thoroughly with soap and water. Wash gloves, boots, respirator before and after removal. Presoak clothes and double launder immediately. If the spill was serious, place the clothes in a plastic bag and dispose in a safe manner.
2. If clothing becomes wet with a pesticide during spraying, remove it immediately, wash and put on freshly laundered clothes.
3. If symptoms of illness occur during or shortly after handling or applying a pesticide, get the patient to a hospital immediately. Take the list of common name chemicals with you to the hospital. (See Emergency Procedures for Pesticide Poisoning on the back cover.)
4. Clean up any pesticide spills immediately. In case of minor spills, use dry soil or other absorbent material to remove excess liquid and sweep up powders and granulars. Contaminated soil and sweepings should be spread over a larger area of bare soil to facilitate rapid degradation. Make sure you are adequately protected when cleaning up the spill.

IN THE CASE OF A MAJOR PESTICIDE "SPILL" THE MINISTRY OF THE ENVIRONMENT, SPILLS ACTION CENTRE, 5TH FLOOR, 7 OVERLEA BLVD., TORONTO, ONTARIO M4H 1A8, TELEPHONE: (416) 965-9619 OR 1-800-268-6060 MUST BE NOTIFIED.

5. If a well becomes contaminated, follow clean-up instructions in **OMAF Factsheet, Pesticide Contamination of Farm Water Supplies, Agdex 607.**

EMERGENCY PROCEDURES FOR PESTICIDE POISONING & FIRST – AID INFORMATION
(see back cover)

RELATIVE TOXICITY TO APPLICATOR

DEFINITIONS

Lethal dose 50% (LD_{50}): The dose which when administered will kill 50% of the test animals within a stated period of time (i.e. 1 to 6 days).

Acute Toxicity: Immediate adverse effects from a single or short period exposure to a substance, either by the oral, dermal or inhalation route.

Chronic Toxicity: Adverse effects resulting from repeated exposure to a substance over an extended period.

High Acute Toxicity

These pesticides are extremely dangerous if handled carelessly. The acute oral LD_{50} are less than 50 mg/kg of body weight and the acute dermal LD_{50} less than 200 mg/kg body weight. These pesticides can be fatal by swallowing less than .1 to 3 mL (one drop to half a teaspoonful). These pesticides carry the skull and crossbones in a stop sign. In using these products, a respirator and eye protection is required along with all other protective clothing:

aldicarb (Temik)
azinphos-methyl (Guthion)
carbofuran (Furadan)
chlorfenvinphos (Birlane)
disolfoton (disyston)
endosulfan (Thiodan)
fonofos (Dyfonate)
methamidophos (Monitor)
methomyl (Lannate)
methyl bromide (MC-2, MB-C_2)
oxamyl (Vydate)
parathion

Moderate Acute Toxicity

These pesticides are dangerous if handled carelessly. The acute oral LD_{50} is 50 to 500 mg/kg of body weight and the acute dermal LD_{50} is 200 to 2000 mg/kg body weight. These pesticides can be fatal by swallowing 3 and 30 mL (half a teaspoonful to 2 tablespoonsful). These pesticides carry the skull and crossbones on a stop sign. In using these products, a respirator and eye protection are recommended when handling the concentrate along with all other protective clothing:

chlorpyrifos (Lorsban)
1, 3-D (Telone II, Telone C-17, Vorlex Plus, Vorlex Plus CP)
diazinon (Basudin)
dimethoate (Cygon)
Lindane
oxydemeton-methyl (Metasystox R)
phosmet (Imidan)
pirimicarb (Pirimor)

Low Acute Toxicity

These pesticides are not fatal unless deliberately ingested in amounts of over 30 mL (1 oz.). The acute oral LD_{50} is greater than 500 mg/kg body weight and the acute dermal LD_{50} greater than 2000 mg/kg body weight. Pesticides listed in this publication and not appearing in the lists in this section have low acute toxicities and should be handled with precaution. Protective clothing are required. Respirators are advised when used in confined spaces. Eye protection is advisable.

Chronic Toxicity

It is not possible to assess chronic toxicity of a pesticide in the same way as an LD_{50} is used to determine acute toxicity. Instead, a number of tests are performed on animals which help predict whether a pesticide will cause a number of possible long-term effects. Animals are examined for a wide variety of toxic effects such as the production of tumors or abnormalities. Protective clothing and equipment is advisable to reduce exposure and the risk of chronic effects.

REENTRY TO TREATED AREAS

Pesticide poisoning may occur where workers enter fields too soon after pesticides have been applied. Such poisoning can result from handling the treated plants or from inhalation of pesticide fumes. The following pesticides are those for which a specific minimum interval must be observed from the time of application to the time of working in the crop. For some pesticides, e.g. parathion, the label carries a warning regarding working in treated crops. **Follow these recommendations.** Where no label warnings are provided, the following minimum intervals are recommended:

24 HOURS	48 HOURS	7 DAYS
methidathion (Supracide)	aldicarb (Temik)	parathion
methomyl (Lannate)	azinphos-methyl (Guthion)	
oxamyl (Vydate)	carbofuran (Furadan)	
	chlorfenvinphos (Birlane)	
	methamidophos (Monitor)	
	oxydemeton-methyl (Metasystox-R)	

BLOOD TESTS FOR THOSE APPLYING PESTICIDES

Organophosphorus and carbamate pesticides are capable of inactivating the serum and red blood cholinesterase levels. If the activity of the cholinesterase falls below a critical level, human poisoning can result as exhibited by fatigue, dizziness, nausea, trembling, blurred vision, difficulty in breathing and other symptoms.

For those working outdoors and applying these groups of pesticides, it is strongly recommended that cholinesterase levels be checked by your family doctor. To be of value, the tests should be commenced **before** using these pesticides and not after applications have commenced, since the normal level per individual can vary considerably, making it difficult to assess the degree of suppression. In this publication the primary insecticides of concern are:

azinphos-methyl (Guthion, APM)
aldicarb (Temik)
carbaryl (Sevin)
carbofuran (Furadan)
chlorfenvinphos (Birlane)
chlorpyrifos (Lorsban)
diazinon (Basudin)
dimethoate (Cygon)
disulfoton (Di-Syston)
fonofos (Dyfonate)
methamidophos (Monitor)
methidathion (Supracide)
methomyl (Lannate)
mevinphos (Phosdrin)
oxamyl (Vydate)
oxydemeton-methyl (Metasytox-R)
parathion
phosmet (Imidan)
phorate (Thimet)
pirimicarb (Pirimor)

PROTECTIVE CLOTHING WHEN USING PESTICIDES OUTDOORS

1. **Why Use Personal Protection?** Pesticide formulations vary in their toxicity from slightly to extremely poisonous. Once the pesticide is removed from the container, exposure occurs. The toxicity of the pesticide and the exposure to the user creates a hazard which varies from spray operation to spray operation. Both can be reduced, toxicity by dilution and exposure by protective clothing. The action taken by the applicator to reduce the hazard of a spray operation reduces the risk of poisoning. While the hazard of a situation remains, the risk can be reduced by the care and protection measures followed by the applicator. Wearing the required protective clothing reduces the risk.
2. **Risk of each stage in pesticide operation**
   (1) Handling and mixing concentrate — very high risk
   (2) Rinsing empty containers — high risk
   (3) Application outdoors — low to high risk
   (4) Application indoors — medium to very high risk
   (5) Clean-up, equipment rinsing — medium to high risk
   (6) Reentry into treated area up to 48 hours — low to medium risk
3. **Exposure of each stage in pesticide operation**
   Approximately 80-85% of the exposure in most spray operations is during mixing and loading of the concentrate. Field application usually accounts for 15-20% of the exposure. Skin exposure is usually 90 to 100% of the total exposure and around 70% of this is by way of the hands and forearms and 30% involves the rest of the body. Inhalation (nose and mouth) exposure is normally 0.1% but rises to 5-10% with mist blowers and air blast sprayers.
4. **To reduce skin (dermal) exposure,** wear impervious gloves (neoprene, rubber, etc.) and waterproof boots, along with coveralls, apron or spray suits and waterproof cap. Coveralls can be reusable or disposable. Reusable coveralls are normally cotton or polyester and should be tightly woven. Polyester is more easily penetrated than cotton. Disposable coveralls are polyethylene and can be laundered several times. Spray suits should be used in highly hazardous conditions as with mist blowers and air blast machines. Eye protection should be practiced with all pesticide concentrates.
5. **Respirators are recommended** when handling pesticides with labels carrying the warning stop sign with skull and crossbones that call for respiratory protection. Respirators should be used when spraying all pesticides rated as having a high toxicity or applying any liquified gas. Respirators come in a wide range of shapes and sizes; consult the label and your nearest safety supply company for advice.
6. **Washing and laundering protective clothing**
   To keep your protective clothing and equipment functional, clean it thoroughly. Never allow children or pets to come into contact with contaminated clothing or equipment. To this end, launder clothing promptly, wash and store other items used for personal protection and rinse down spray equipment and store to prevent children playing on it. Here are some general guidelines for cleaning items used for personal protection.
   (1) **Fabric clothing** — If fabric clothing is saturated with the concentrate of a highly toxic pesticide, then discard the clothing. Remove the clothing carefully and immediately place in a plastic trash bag and dispose in a safe manner. Wear rubber, vinyl, or plastic gloves when handling severely contaminated clothing. Presoak and double launder clothes that may have been contaminated by a normal spray operation, preferably twice a day but at least at the end of the work day, following these guidelines:
   — prerinse clothing outdoors
   — presoak in a suitable container such as a large bucket or tub; or use the prewash cycle of an automatic washer, with detergent
   — wash contaminated clothing separately from all other clothing
   — prewash, solvent-based products have been found effective on EC formulations
   — wash clothes using hot water, the highest water level, and a regular hot super wash cycle
   — use heavy-duty liquid detergents for all pesticides and use adequate amounts (see laundry detergent box)
   — wash only a few contaminated garments at a time
   — use two complete wash cycles, each with a double rinse
   — after washing run another wash cycle with detergent and no clothing to decontaminate the washing machine
   — line dry to avoid a potential build-up of pesticide residue in the dryer
   (2) **Rubber, Vinyl, or Plastic Boots and Gloves** — To avoid getting pesticide on your hands, wash the outside of boots and gloves with detergent and water before removing. After removing boots and gloves, wash them inside and out with detergent and water, rinse thoroughly, and dry in a well-ventilated area.
   (3) **Chemical-Resistant Clothing, Goggles and Face Mask** — Wash plastic or rubber clothing and equipment with detergent and water, rinse thoroughly, and dry in a well-ventilated area.
   (4) **Respirators** — Discard cartridges, canisters and filter pads either: (1) when breathing becomes difficult, (2) when a pesticide odor is noticed, or (3) at the time interval specified by the manufacturer. Write the date the cartridge is first used. Wash the face piece in detergent and water, rinse it thoroughly, and dry it in a well-ventilated area. Never use alcohol or other solvents for cleaning — they will damage rubber and plastic.
7. **Consult the safety supply house** of your choice for appropriate guidance and selection of your protective clothing.

PROTECTIVE CLOTHING WHEN USING PESTICIDES IN GREENHOUSES, MUSHROOM HOUSES, GRAIN STORAGES AND OTHER ENCLOSED AREAS

Respiratory Protection — Available Devices

Air Purifying Devices — Canister Gas Masks

Canister gas masks have been used effectively for many years by greenhouse applicators for respiratory protection against certain gases, vapors and particulate matter which otherwise might be harmful to life or health.

From a practical standpoint, canister gas masks are generally suitable for ventilated areas not subject to rapid change, but should

never be used in confined spaces where oxygen deficiency and high gas concentrations may occur.

Self-contained Breathing Apparatus

In confined spaces where gas concentrations are usually high, oxygen can be deficient and conditions can be fatal. Under these conditions air purifying apparatus fail to work. The applicator needs an air supply and this is provided by a self-contained breathing apparatus (e.g. Scott Air Pack). The use of substances that produce hydrogen cyanide, methyl bromide, chloropicrin, or phosphine can all produce high gas concentrations and oxygen deficiency as can smoke generators and even foggers using highly toxic pesticides and some volatile sprays. Greenhouse and mushroom house operators need this type of apparatus in using these toxic gases, smokes, fogs or sprays.

OTHER PROTECTIVE CLOTHING

Wear other protective clothing in keeping with requirements on the label.

WORKING CONDITIONS

Low Concentrations

Canister gas masks may be used when the surrounding air contains low concentrations of toxic gases, vapors or particulate matter derived from soil-drench, granular, dust, or foliar spray applications. Pesticides applied in such manner are usually of moderate to low toxicity. The exceptions include aldicarb (Temik 10G) which is highly toxic. However because it is available as a granular, the wearing of a canister gas mask provides protection. Contact your safety supply company for the proper canister selection.

High Concentrations

Use only a self-contained breathing apparatus (e.g., Scott Air Pack) in the following instances when high concentrations are produced. High concentration of toxic gases, vapors or particulate matter can be produced when applying highly toxic pesticides such as:

1. When fumigating grain — methyl bromide
2. When fumigating soil — methyl bromide, 1,3 Dichloroproprene (Telone & Vorlex)
3. When fogging — Parathion
4. When using smoke generators — Parathion, Nicotine, Sulfotep, Lindane
5. When high pressure, mist, application — Dichlorvos

Contact your safety supply company for their recommendation for each.

SPACE FUMIGANTS AND INSECTICIDE SMOKES

General

When using fumigants or insecticide smoke generators, wear appropriate protective clothing to prevent skin and inhalation exposure. After treatment lock the building where the extermination is being performed and post warning signs. Follow instructions on the product label regarding aeration of treated buildings, warehouses, grain storage bins or areas and greenhouses before permitting reentry. BECOME FULLY AWARE OF THE HEALTH HAZARDS AND TOXIC PROPERTIES OF THE PESTICIDE THAT YOU ARE USING.

Fumigants

An agriculturalist using methyl bromide plus chloropicrin to fumigate greenhouses, vaults, warehouses, and grain storages must obtain a permit issued under The Pesticides Act.

To apply for a permit, contact the local Pesticide Officer with the Ministry of Environment.

When handling methyl bromide, do not wear any gloves because these will trap gas close to the skin. A full face respirator with organic vapor canister or positive pressure breathing apparatus must be worn. A second person with personal protective equipment should be assisting during the fumigation.

Always consult the product label.

For further information, obtain **Methyl Bromide Structure Fumigation Procedures** from the Ministry of the Environment offices.

SAFETY SUPPLY COMPANIES IN ONTARIO PROVIDING PROTECTIVE CLOTHING AND/ OR RESPIRATORY DEVICES FOR OUTDOOR PROTECTION AGAINST CERTAIN PESTICIDES

Respiratory Devices Manufactured by:	Available From:
American Optical	AOCO Limited, Subsidiary of American Optical Corporation, 80 Centurion Drive, Markham L3Y 5Y5 Tel. (416) 479-4545 Branches: Hamilton & Belleville
H.S. Cover (York) Survivair	Levitt-Safety Ltd., 33 Laird Drive, Toronto M4G 3S9, Tel. (416) 425-8700 Branches: Kitchener, London, Ottawa, Sarnia, Stoney Creek, Sudbury and Thunder Bay
Kasco Helmets	The St. George Co., R.R. #1, St. George N0E 1N0, Tel. (519) 442-2046
Mine Safety Appliances	MSA Canada Inc., 148 Norfinch Drive, North York M3N 1X8, Tel. (416) 667-9400
3M Occupational Health & Safety Prod. Div. Racial Airstream Scott Willson	Safety Supply Canada, 90 West Beaver Creek Road, Richmond Hill (Toronto) L4B 1E7, Tel. (416) 222-4111 or (416) 222-2111 Branches: Hamilton, Kingston, Kitchener, London, St. Catharines, Sarnia, South Porcupine, Thunder Bay, and Windsor
North	Siebe-North Inc., 27 Dansk Court, Rexdale M9W 5V8, Tel. (416) 675-2810
Safety House	Safety House of Canada Ltd., 1275 Castlefield Ave., Toronto M6B 1G4, Tel. (416) 789-0631 Branches: Kitchener, London, Orillia, Ottawa, St. Catharines and Stoney Creek

Many of the companies listed above have dealer outlets in addition to branch outlets. For details of dealer outlets contact the supply company of your choice.

STORAGE

1. **General Storage**
   The Ontario Pesticides Act and Regulation 751 requires that all pesticides be kept out of the reach of children, irresponsible persons, pets and livestock. They should be stored in a locked facility away from food for humans and feed for animals. Herbicides should be stored separately from other pesticides to avoid possible contamination.

2. **Special Storage**
   (1) Schedule 1, 2 and 5 pesticides must be stored in a storage facility which is ventilated to the outside atmosphere. A placard bearing the words "CHEMICAL STORAGE WARNING-AUTHORIZED PERSONNEL ONLY" in block capitals must be affixed to the outside of each entrance. Entry to the storage facility should only be made by the person responsible for the pesticide or with his permission.

   (2) **Always store pesticides in original containers and keep them tightly closed. Never put pesticides in unmarked containers.** Also see, **OMAF Factsheet, Farm Storage of Pesticides, Agdex 607.**

   (3) In areas where flooding has been a frequent occurrence, fertilizers and pesticides must be stored above the known high-water mark to avoid contamination of the flood waters. Contamination of water by these chemicals can and has led to serious health problems affecting humans and domestic animals as well as fish and wildlife.

DISPOSAL OF PESTICIDE CONTAINERS OR CONTAMINATED MATERIAL

1. All paper or cardboard pesticide containers or paper packaging material, or other paper material used to clean up spills should be buried or burned. Make sure that people and animals are kept away from the smoke, and that the smoke is not directed toward buildings, highways, roads, or outdoor public areas. Plastic material must not be burned.
2. Unrinsed containers can contain as much as 3% of the original formulation. If this amount of toxic pesticide is discarded with the container it could be dangerous to other people handling it, or to the environment (for example, your water supply). Failure to rinse is also wasteful – why not use that 3% for the purpose for which it was purchased, i.e. to control the pest!
3. Rinse all empty metal, plastic or glass containers three times with water and add washings to the spray tank. Or, use a rinsing device. These rinsers can be used to puncture the bottom of a metal or plastic container and rinse the residue left in the container directly into the spray tank. This procedure takes less than a minute. The rinsed containers may be crushed, buried and covered by at least 50 cm of soil, away from any watercourse or water table, or disposed of at a landfill site.
4. Unwanted or contaminated pesticide product should be disposed of through TRICIL Environmental Management (**1-800-263-2432**), or by contacting the appropriate registrant to develop an alternative method acceptable to the Director under the Pesticides Act (**1-416-323-5095**).

PESTICIDE DRIFT

Pesticide drift can leave unwanted residues on adjacent crops, be a hazard to people and livestock nearby, and reduce the amount of material in the target area so that it is ineffective.

Those applying pesticides should make every effort to minimize or prevent pesticide spray drift by:

1. correct calibration and maintenance of spray equipment
2. correct operation of the equipment
3. being aware of the toxicity of the pesticide being used
4. being aware of the weather conditions

For more information, **consult OMAF Factsheet, Reducing Pesticide Drift and Crop Damage, Agdex 607, or Canadex 607, Pesticides: effects of drift and droplet size.**

PESTICIDE APPLICATION BY AIRPLANE OR HELICOPTER

Acrial applicators must be licenced by the Ontario Ministry of the Environment to apply pesticides. In addition, permits are required from the Ontario Ministry of the Environment under the authority of The Pesticides Act for the application of Schedule 1 and 5 pesticides and Schedule 2 hormone-type herbicides. The area will be inspected by Ministry personnel to ensure safety of application.

It is an offence under the Federal Pest-Control Products Act to use a control product under unsafe conditions. Precautionary practices must be heeded at all times to prevent drift. Extra precautions should be taken when using insecticides applied by air, especially those known to be toxic in honeybees, e.g., Sevin (carbaryl).

Applications should not be made if the wind is blowing. Even on the stillest day, some drift occurs; to keep it to a minimum, apply pesticides in the evening or early morning.

Be sure that the contract specifies the product to be used and its rate of application.

RESIDUE TOLERANCES AND DAYS TO HARVEST

Tolerances for residues of agricultural chemicals on vegetables when offered for sale have been set by Health and Welfare Canada. To avoid exceeding the residue tolerance for insecticides, herbicides and fungicides:

- DO NOT APPLY THEM LATER THAN RECOMMENDED.
- DO NOT APPLY MORE THAN THE RECOMMENDED AMOUNT.
- DO NOT APPLY THEM MORE OFTEN THAN RECOMMENDED ON THE LABEL.

When controlling insects, for example, **do not apply an insecticide later than the number of days from harvest given in brackets after the recommendation.** Malathion 25% WP 4.5 kg (7 days) indicates that the malathion spray should not be used later than 7 days before the beginning of harvest and that no more than 4.5 kg of a wettable powder formulation containing 25% malathion should be used for one hectare of crop in an application.

CROP INSURANCE

The Government of Canada provides financial assistance to the Canada-Ontario Crop Insurance Program by contributing 50% of the total premium required each year. The Federal Government's contribution to this program totalled $16.0 million for the 1989 year.

The Government of Ontario paid $5.6 million for administrative costs. In addition, due to increased participation in the program, the Ontario Government contributed $10.0 million to the required premium. These contributions enable a grower to purchase insurance protection at a premium considerably below that which would otherwise be payable.

The premium is also an operating expense for income tax purposes.

Crop insurance offers protection against loss from a broad range of production hazards, including excessive rain, excessive drought, winter damage, frost, hail, wind, certain pests and diseases, etc.

For further information, contact your local insurance agent or:

The Crop Insurance Commission of Ontario
Ministry of Agriculture and Food
Legislative Buildings
TORONTO, Ontario M7A 1B7
416-326-3276

For those crops listed and followed by "processing", be advised that insurance contracts are available through processing companies only. Insurance contracts for all other crops listed are available from Crop Insurance Agents only.

VEGETABLE CROPS

Asparagus
Beans (green & wax for processing)
Beets
Broccoli
Cabbage
Carrots
Cauliflower
Celery
Cucumbers
Lettuce
Lima Beans (processing)
Parsnips
Peas (processing)
Peppers
Potatoes
Pumpkins
Rutabagas
Seed Onions
Set Onions
Spanish Onions
Squash
Sweet Corn (fresh)
Sweet Corn (processing)
Tomatoes (fresh)
Tomatoes (processing)
Greenhouse Tomatoes
Greenhouse Cucumbers

FRUIT CROPS

Apples
Grapes
Peaches
Pears
Plums
Sour Cherries
Strawberries
Sweet Cherries

GENERAL CROPS

Canola
Colored Beans
Corn (grain & silage)
Hay
Honey
New Forage Seeding
Peanuts
Popcorn
Red Spring Wheat
Seed Corn
Soybeans
Spring Grain
Sunflowers
White Beans
Winter Wheat

TOBACCO

Flue Cured
Black

SPRAY-TANK MIXTURES IN ALKALINE WATER

Because many pesticides are susceptible to alkaline water[1], it is recommended that pesticides diluted with alkaline water be used immediately.

However, "spray immediately" is not always possible owing to unexpected reasons – rain, wind, sickness, etc. Any delay in applying spray mixtures will result in pesticide loss due to degradation[2] and possibly a corresponding decrease in control.

To avoid this possibility, it is recommended that alkaline water be neutralized before adding any pesticides. Dissolve ammonium dihydrogen phosphate[3] (same material is also called mono-ammonium phosphate or ammonium phosphate, monobasic) at the rate of 50 g per 100 litres of water, and then add pesticides. Alternatively, LI 700 used at a rate of 125 mL to 250 mL in 100 L of water may be mixed into the tank water before adding any pesticides.

The phosphate is not always necessary, but this practice is a sort of insurance. The cost of the phosphate is substantially less than that of the pesticides. Also, the added phosphate will be available as a foliar nutrient.

Occasionally, water-soluble fertilizers are used with pesticides as a tank mixture. This practice is not encouraged because most of the water-soluble fertilizers are strongly alkaline. If these fertilizers are used, the amount of phosphate recommended is not sufficient to neutralize the water.

1 *Most of the water being used in the Holland Marsh and many water sources in the Niagara Peninsula are fairly alkaline (pH 7.5 - 9.0). Possibly there are other areas in Ontario where alkaline waters are being used.*

2 *The rate of degradation is dependent on the pesticide, the concentration of pesticide in the tank (dilution factor), and the pH and temperature of the water.*

3 *The phosphate is available from limited suppliers. The cost of ammonium dihydrogen phosphate is $1.68 per kg ($84.00 per 50 kg as of October, 1989). For 100 L of water, the cost (50 g of phosphate) is 8.4 cents.*

COMPATIBILITY OF INSECTICIDES AND FUNGICIDES

The chart below is only a **guide** to mixing of spray materials.

Consult the manufacturer's label regarding compatibility of products with other pesticides. Compatibilities of some materials depend upon solvents and emulsifiers used by the manufacturer. As all manufacturers do not use the same solvents and emulsifiers, **be sure to check the label or product being used for compatibility.**

Chart applies **only to the use of two-material spray combinations.** When three or more materials are tank-mixed together, further incompatibility may develop.

COMPATIBILITY-CHART KEY

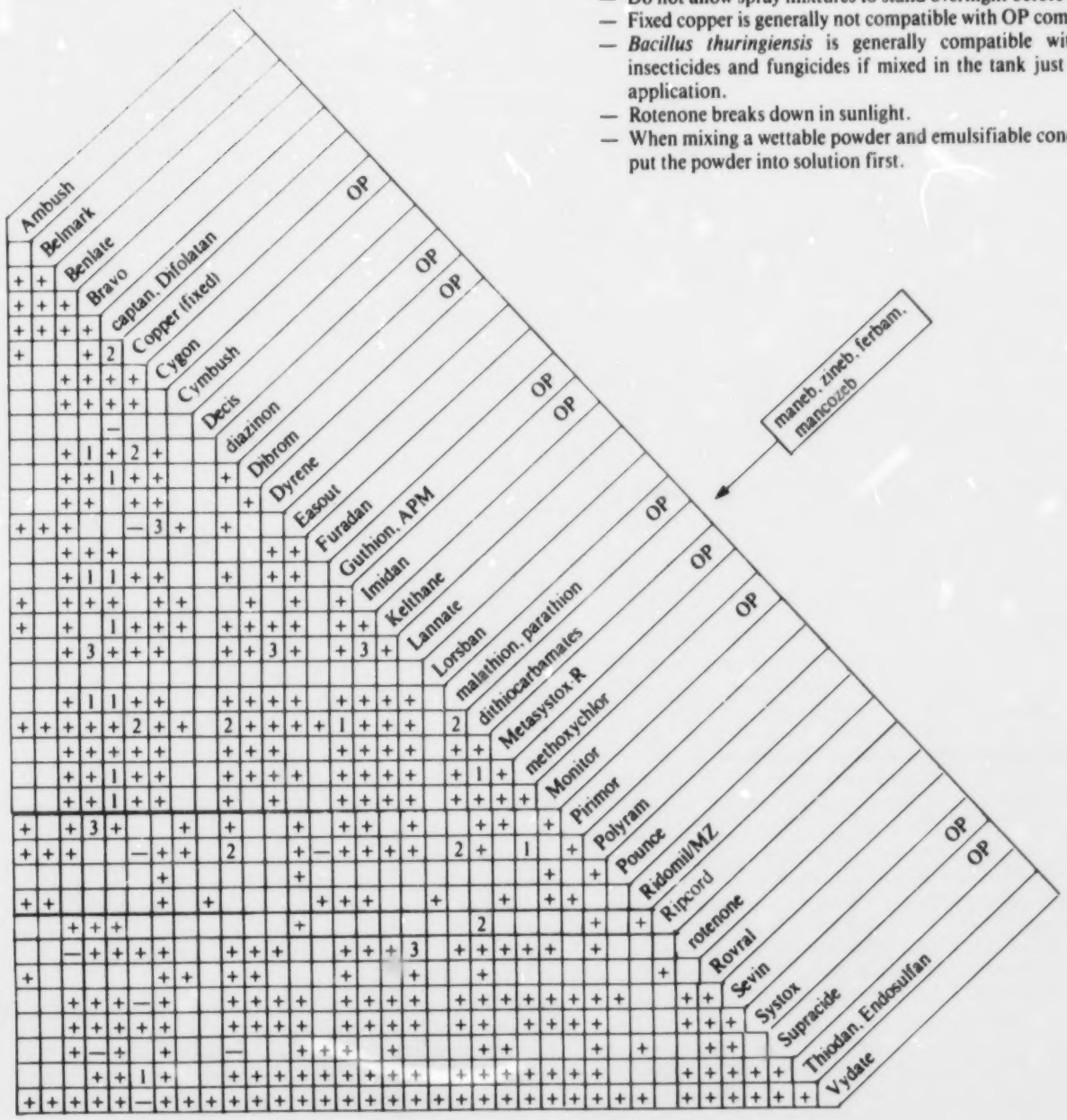
When a blank appears on the chart, the materials usually are not used together or the compatibility is not known.

\+ May be used together
— Do not use together
OP Organophosphorus compound

1 Use WP formulations
2 Apply immediately with tank agitation
3 Use with caution (possible plant injury)

Special Notes

— Do not mix pesticides with foliar fertilizers.
— Do not allow spray mixtures to stand overnight before using.
— Fixed copper is generally not compatible with OP compounds.
— *Bacillus thuringiensis* is generally compatible with most insecticides and fungicides if mixed in the tank just prior to application.
— Rotenone breaks down in sunlight.
— When mixing a wettable powder and emulsifiable concentrate, put the powder into solution first.



CLIMATE OF ONTARIO

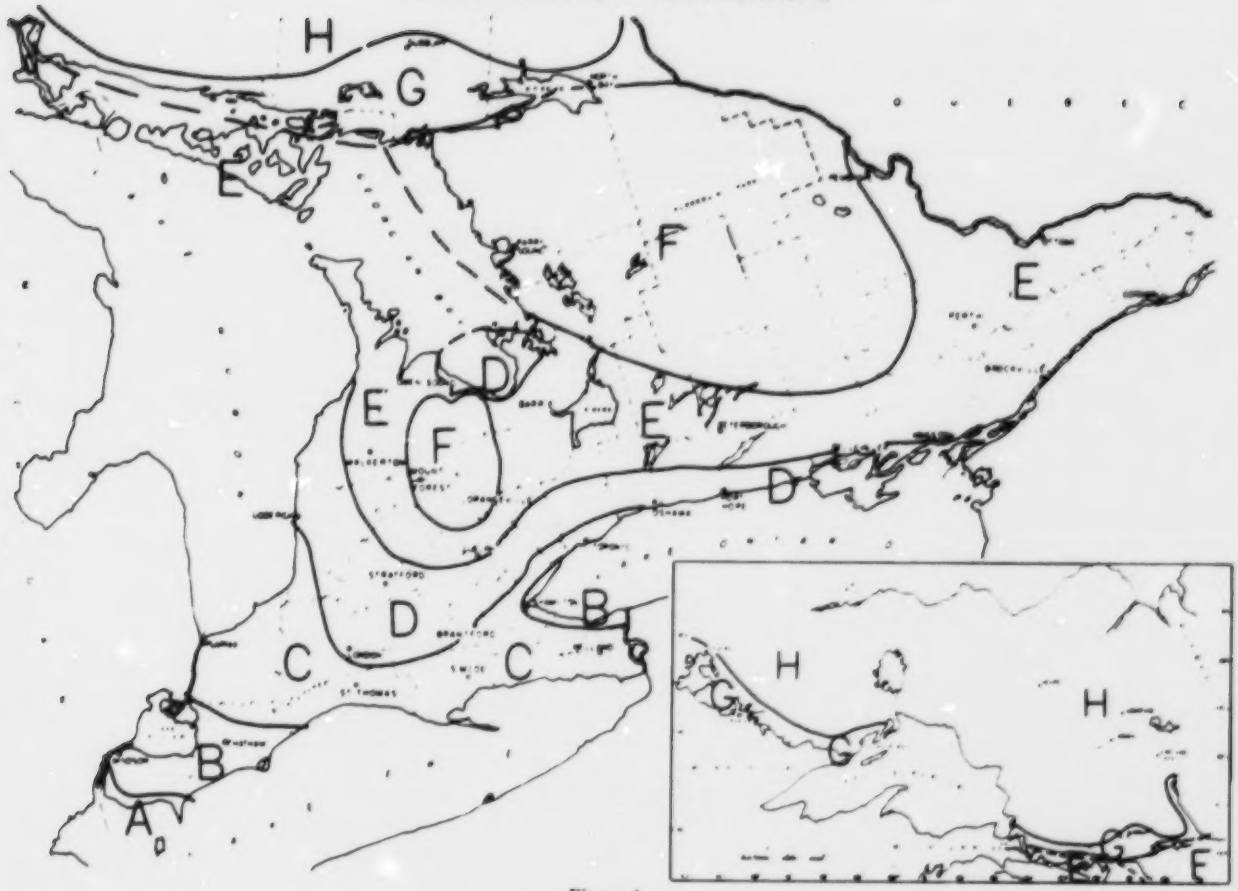


Figure 1

Most vegetable production is concentrated in southern Ontario. There are differences in climate even in this small area, particularly in the length of the growing season and in average temperatures.

Figure 1 is a Zonation Map of southern Ontario. Zone A has the longest growing season and is the small region in the Leamington-Harrow-Amherstburg area bordering on Lake Erie. The other zones are progressively shorter in growing season. The zone lines are approximate and do not represent sharp changes in climate. The gradation of temperature and growing season from one zone to another is gradual.

TABLE 1. AVERAGE FROST-FREE PERIOD IN CLIMATIC ZONES OF ONTARIO

Zone	Average frost-free period (days)	Average date of last spring frost	Average date of first fall frost
A	165 or more	May 1	October 13
B	155-165	May 8	October 10
C	150-155	May 11	October 7
D	140-150	May 15	October 2
E	120-140	May 22	September 25
F	110-120	June 1	September 17
G	95-110	June 8	September 12
H	95 or less	After May 31	Before September 10

Table 1 gives approximate growing periods for tender crops and average dates of first and last frost (0°C) in each zone. These average frost dates are approximate guides to the beginning and end of the frost-free period in 5 out of 10 years. For example, in past records from Zone C the last spring frost still occurred later than May 11, or the first fall frost occurred before October 7, in 5 out of 10 years. This 5-out-of-10 risk level may be excessive for planning many farm operations, so frost dates with lower risk levels may be determined as follows. Three years in 10 the first frost will occur about one week later in the spring or one week earlier in the fall than the date given in Table 1. For the 1-year-in-10 risk, the dates in Table 1 should be adjusted about 2 weeks later in spring and 2 weeks earlier in fall. For example, 1 year in 10 the last spring frost in Zone C has occurred later than May 25 or the first fall frost has occurred earlier than September 24.

Table 1 and the above paragraph refer to the occurrences of 0°C at a standard height of 1.5 metres at which time tender crops will often be damaged. Frost-hardier crops are not usually damaged until temperatures at this level drop below —2°C. The date of occurrence of —2°C is usually about 2 weeks earlier in the spring or later in the fall than the date of 0°C.

It is obvious that there are many local variations due to topography, altitude, natural air drainage and nearness to water that influence growing conditions. Cold air tends to flow, like water, into low-lying areas. Plants may be frost damaged at the bottom of a slope and not have been injured on the slope or at the top of the hill.

Particularly during spring, a south-facing slope or an area surrounded by a windbreak will be warmer than an unprotected area. These local variations must be considered in deciding the location of a planting or the time of planting.

Table 2 gives approximate first seeding or planting dates for common vegetable crops. Dates are given for Zones A, C and E. Planting dates for the other zones fall between these dates.

These dates are a guide for seeding but seasons will have to be taken into consideration. If long-term weather predictions are available, they are helpful in deciding whether to seed earlier or later than the dates given. For many crops the soil temperature is very important in determining the rate of early growth. For this reason, even if air temperatures are high, if the soil has not yet warmed up, planting should be delayed somewhat.

TABLE 2. FIRST FIELD SEEDING OR PLANTING DATES FOR COMMERCIAL PRODUCTION

Crops	Zone A	Zone C	Zone E
FROST HARDY Asparagus, broccoli, Brussels sprouts, cabbage, lettuce, onions (set, seed and Spanish) radish, rhubarb, pea, spinach, parsnip, early potato	April 1-15	April 15-25	April 25-May 10
SEMI-FROST HARDY Beet, carrot, cauliflower, celery, late potato, early sweet corn	April 15-25	April 25-May 10	May 5-15
SEMI-FROST TENDER Snap bean, sweet corn, tomato	May 1-15	May 15-25	May 25-June 5
FROST TENDER Lima bean, cucumber, eggplant, muskmelon, pepper, pumpkin, squash, watermelon	May 20-30	May 25-June 5	June 5-15

PLANT POPULATION AND PRECISION SEEDING

The use of herbicides, fertilizers, and, to some extent, irrigation, has drastically changed the way vegetable crops can and should be grown. Most crops can be grown much closer than the old conventional spacings, which were approximately the width of a horse-drawn cultivator. Much closer spacing allows more crop on the same unit of land. Each crop should be spaced according to its optimum needs. Seeding carrots 2 to 4 cm apart in all directions eliminates most stress factors, resulting in uniform carrots relatively free from disease and misshapen roots. More than 8 to 12 rows of carrots per bed, at 4 x 4-cm spacing, will interfere with light penetration of the foliage cover and adversely affect yield. Lettuce seeded in beds and spaced 30 cm between plants produces more heads per unit of land, as well as a much higher percentage of marketable heads. Onions sown in double rows 5 to 8 cm apart in and between the double rows, 4 to 6 double rows per bed, not only produce larger onions but much higher yields. The same can be said for many other crops. As plants reach the optimum spacing for their particular needs, growth improves and yields increase.

To obtain the optimum plant density, a system of precision seeding is needed. This system starts with the preparation of a fine, smooth seedbed, followed by uniform seeding at the same depth, at exact in-row and between row spacings. See crop sections for spacing requirements.

With precision seeding, the harvested product will be more uniform in size and shape. Less effort will be required in grading and packing, and fewer culls will be obtained.

However, to achieve complete success with precision seeding, all factors — seed sizing, seed coating, high germination, uniform bed characteristics, and uniform seeding depth — must be included. By omitting just one factor, the results may be no better than with more conventional seeding methods.

The distance between rows will be determined by the method used to harvest the crop. Solid-bed planting can be done with some crops.

A precision seeder delivers the seed exactly where the final plant for harvest is to be grown. If this is accomplished, and the seed germinates normally, no thinning or transplanting will be required. The "ifs" are the quality of the seed and the uniformity of the seedbed.

Another important factor to consider is the kind of seed coat. Rough or angular seed like carrot and lettuce must be coated to a smooth, uniform shape with a water-absorbing material. Onions need to be coated to be successfully precision seeded. Seeds that are naturally smooth and round, such as cabbage, cauliflower, radish and rutabaga, need only to be separated to exactly the same sizes to provide uniform growth in the field. Results with precision-seeding research in Ontario to date indicate that higher yields of better quality vegetables are possible, regardless of when the crops may be grown.

Pre-germinated seed of most species will ensure more rapid emergence and may gain time or emergence over the slower non-germinated seed. This can assist the seed to emerge before soil crusts form or weed seeds emerge.

SEEDS

APPROXIMATE PLANTING DEPTH AND NUMBER PER GRAM

Crop	Seeds per gram	Seed Planting Depth in mm	Crop	Seeds per gram	Seed Planting Depth in mm
Asparagus	50	25	Kale	270	5
Bean, snap	2-3	40	Kohlrabi	280	5
Bean, lima	1-3	40	Leek	350	15
Beet, Swiss Chard	50	15	Lettuce	700	5
Broccoli	320	5	Melon	40	25
Brussels sprouts	280	5	Mustard	550	5
Cabbage	300	5	Onion	280	15
Chinese cabbage	250	5	Parsley	550	5
Carrot	900	5	Parsnip	200	15
Cauliflower	350	5	Pea	3-6	25
Celery, Celeriac	1,800	3	Pepper	150	5
Chicory	600	5	Pumpkin	4	25
Collard	280	5	Radish	125	15
Corn	4-8	40	Rutabaga	280	5
Cucumber	40	20	Spinach	90	20
Eggplant	200	15	Squash	10	25
Endive	500	5	Tomato	350	5
			Watermelon	10	25

NUMBER OF PLANTS PER HECTARE AT VARIOUS PLANTING DISTANCES

Row Spacing in cm	Distance in the row in cm						
	10	15	30	45	60	75	90
30	333,330	222,220	111,110	74,070	55,560	44,440	37,040
45	222,220	148,150	74,070	49,380	37,040	26,630	24,690
60	166,670	111,110	55,560	37,040	27,780	22,220	18,520
75	133,330	88,890	44,440	29,630	22,220	17,780	14,810
90	111,110	74,070	37,040	24,690	18,520	16,460	12,350
110	90,910	60,610	30,300	20,200	15,150	12,120	10,100
120	83,330	55,560	27,780	18,520	13,890	11,110	9,260

WEED CONTROL

For chemical weed-control recommendations, refer to OMAF Publication 75, 1990 Guide to Weed Control. It contains details on the various herbicides, safety precautions, care and calibration of sprayers, etc.

Herbicides should not be used in greenhouses and other plant-growing structures unless specifically recommended.

Chemical weed control should never be a substitute for good cultural practices. Reduce the spread or increase of weed seeds by cutting or disking weeds before they go to seed. Concentrate on the eradication of persistent perennial weeds by cultural practices. Thorough working of the land prior to seeding or planting will kill many small weeds that have just germinated. Careful shallow cultivation is best. The modern grower should use chemical weed killers wherever practical as a supplement to good cultural practices.

It is very important to apply the correct dosage when using these chemicals. Herbicides can cause severe injury to the crop if more than the recommended rate is used. **Do not experiment with chemicals or mixtures which are not recommended.** If more than a permitted amount of herbicide residue is found in the crop, the entire crop can be seized without compensation to the grower.

CAUTION!

Spray drift can damage or destroy susceptible crops and shrubs for a great distance from the sprayer. Do not use 2,4-D-type herbicides near susceptible crops such as grapes, beans, tomatoes, or tobacco. Take into consideration both the direction and speed of the wind when applying this type of herbicide. Use low pressure whenever possible (200 to 250 kPa is usually enough). **Do not use the same sprayer to apply 2,4-D and similar herbicides as you use for spraying insecticides and fungicides.** Drain and wash out the sprayer immediately after use. **Do not mix different herbicides, or herbicides with other pesticides, foliar fertilizers, surfactants, or detergents unless recommended by competent authorities.**

SOIL MANAGEMENT AND FERTILIZER USE

SOIL CLASSIFICATION AND TYPE

A well-drained, sandy soil is of value for early vegetable crops. Sandy loam and silt loam soils are valuable for the production of most vegetable crops. Muck land is ideal for some salad and root crops. Clay loam and clay soils are used for certain processing crops. Proper fertilization, drainage, irrigation, and cultivation practices are essential on all soils and will extend the range of soils which may be successfully used for vegetable production.

Detailed soil maps of some counties are available from the Communications Branch, Ontario Ministry of Agriculture and Food, Legislative Buildings, Toronto M7A 1A5. These maps give a very good indication of the soil type in your area, but on-the-site examination will also be necessary.

Soils which are well drained and provide a good depth of permeable rooting volume are necessary. Impervious layers or a high water table can reduce the penetration of roots by excluding oxygen. Excessive moisture can be removed by tile drainage.

SUBSIDENCE OF PEAT AND MUCK SOILS

Cultivated peat and muck soils decompose (oxidize) and thus subside gradually at rates of 1 to 3 cm/year. Maintaining a high water table and a low pH reduce the rate of subsidence to less than .05 cm per year. See **OMAF Factsheet, Management of Organic Soils, Agdex 512/31,** for more detailed information on water control and recommended heights of water table for vegetable crops. However, a very wet (or very acidic) soil does not give maximum yields, and is likely to be flooded when rainfall is intense. Wet spots may also be difficult to work and result in uneven crop growth. Recent research has shown that copper (Cu) applied as fertilizer has the residual effect of slowing down degradation, and thus subsidence, by about 50%. It is recommended that 14 kg of Cu/ha be applied annually to peats and mucks in the first 3 years of cultivation and up to 5 kg of Cu/ha added every second or third year thereafter, particularly when onions, carrots or lettuce are grown on the soils.

ORGANIC MATTER AND CROP ROTATION

Soil organic matter breaks down very rapidly with the intensive cultivation used on vegetable land, especially where irrigation is practiced. While rotations including sod crops are most effective in maintaining organic matter, it may be necessary to rely on green-manure and cover crops where rotations are not feasible. Organic soils, such as peats and mucks, do not require these special practices to maintain organic matter.

Grasses or legumes should appear in the rotation on mineral soils at least once every three years, or better, twice every four years. These crops are important in the rotation, since they maintain porosity and good structure in fine-textured soils. They improve the waterholding capacity of sand and sandy loams. In addition to maintaining good soil structure, the organic matter helps to control several common soil-borne vegetable diseases.

GREEN-MANURE AND COVER CROPS

The benefit from these soil-improving crops will be greatest on a soil which is adequately fertilized. As a general rule, apply 30 to 40 kg N/ha with as much phosphate and potash as the crop requires, based on soil tests, to the soil at or before seeding. The recovery of nitrogen applied will amount to about 30% for the first vegetable crop.

The following are suggested as fall-seeded cover crops. The seeding rate is minimum.

1. Winter rye at 180 kg/ha.
2. Domestic or Italian rye grass at 22 kg/ha.
3. Spring wheat or oats at 130 kg/ha where potatoes or a small-seeded vegetable crop is planned. These crops will hold the soil, but will be killed by frost and will not cause any difficulty in seeding the next spring. Winter rye, with heavy straw growth, makes seeding difficult.

The following green-manure crops are suggested for spring seeding.

1. Soybeans at 130 kg/ha inoculated with a suitable culture and treated with a combination fungicide-insecticide seed protectant.
2. Sudan grass at 35 kg/ha where irrigation is available or soil moisture is abundant.
3. A mixture of peas at 65 kg/ha plus oats at 100 kg/ha sown as early as possible in the spring before a late-planted crop.
4. Sweet clover at 12 to 22 kg/ha or a mixture of sweet clover at 12 kg/ha plus red clover at 6 kg/ha where a soil is taken out of cultivation for one year to improve soil structure.

MANURE

Manure is a good source of organic matter and plant nutrients. Whenever available, it should be used.

For maximum conservation of plant nutrients, manure should be stored in a way that saves the liquid portion and allows as little exposure to the air as practicable.

Manure is used more effectively when applied for crops that require nitrogen and on soils that require phosphorus and potassium. Manure should not be supplied at rates giving more nitrogen than the crop requires.

Avoid application of liquid manure to crop foliage, as it can damage the crop.

The most effective use of manure is nitrogen. It should be applied in the spring and covered with soil the same day to prevent loss of ammonia. Immediate covering with soil is estimated to provide 25% more nitrogen to the crop than where the same manure is not covered immediately. Most of the nitrogen loss to the air occurs within the first week after application. Injection of manure is one way of preventing nitrogen loss and minimizing the potential for pollution of adjacent streams with phosphate from surface runoff. However, phosphate applied after a crop is seeded may not be available to that crop. Therefore, phosphate fertilizer requirements should not be adjusted for manure applied after seeding.

If manured soil is plowed in late summer or early fall, a cover crop should be seeded. Manure containing much undecomposed straw or shavings should not be applied in the spring when potatoes are to be grown, as it may promote scab development.

The fertilizer requirements given for each crop in this publication do not contain any adjustment for applications of manure. If manure is applied, the amount of fertilizer to be deducted from the crop requirements is indicated in the accompanying table for each type of manure.

These values assume, for manure applied in the spring and not immediately covered with soil, that 50% of the nitrogen (75% for poultry manure), 40% of the phosphate and 90% of the potash are as available in the year of application as the nutrients in manufactured fertilizer.

REDUCTIONS IN FERTILIZER APPLICATION WHERE MANURE IS APPLIED IN THE SAME CROP YEAR*

Class of Livestock	Nitrogen (kg/ha) F. & W.**	Spr.**	Spr. C.**	Phosphate P_2O_5 (kg/ha)	Potash K_2O (kg/ha)
Liquid Manure at 10 cubic metres/hectare (One cubic metre + 220 imp. gal; one cubic metre/ha = 90 gal/ac)					
Cattle, Mixed Livestock	5	10	12	4	16
Swine	8	15	19	7	14
Poultry	23	46	58	22	26
Solid Manure at 10 tonnes/hectare (66 bu. or 2.40 cubic metres of solid manure = 1 metric tonne approximately. Ten t/ha = 4.5 ton/ac.)					
Cattle, Mixed Livestock	12	24	30	10	44
Swine	15	30	38	20	26
Poultry	70	140	175	75	96

* *These adjustments are based on slightly below average-quality manure.*

** **F. & W.** *denotes fall and winter-applied manure;* **Spr.** *denotes spring applied and not covered immediately, including surface application after seeding;* **Spr. C.** *denotes spring-applied manure injected or otherwise covered within one day of application.*

Where the manure is applied in the fall, more nitrogen is lost (to the air and by leaching) than when spring applied. The nitrogen adjustments should be 50% lower for fall-applied manure than for spring-applied manure which is not immediately covered (see table). Phosphate and potash are believed to be equally available from fall and spring-applied manure.

If manure must be spread in the winter, nitrogen adjustments should be the same as for fall applications. Do not spread manure in winter or early spring on fields that are subject to runoff.

LONG-TERM VALUE OF MANURE

The long-term availability of phosphorus, potassium and magnesium from manure applications in previous years is best measured by a soil test. Some of the nitrogen in cattle and swine manure also continues to become available in the years following application but in successively smaller quantities. Generally, 50 percent of the total manure nitrogen applied in the spring is available (as nitrogen in chemical fertilizer) in the year of application. In the second year approximately 20% of the remaining nitrogen becomes available, 10% in the third year and 5% in the fourth year. Thus if 20 tonnes of cattle manure per hectare were applied, the amount of nitrogen available in the first year would be 48 kg N/ha. This is approximately one-half of the total nitrogen content. The amounts of available nitrogen in years 2, 3 and 4 would be 10, 4, and 2 kg N/ha, respectively. If manure has been applied annually for a number of years, the cumulative amount of nitrogen is appreciable. For example, if 20 tonnes of cattle manure per hectare were applied each year for four years, the total available nitrogen from the manure in the fourth year would be 48 + 10 + 4 + 2 = 64 kg N/ha.

Although time and method of manure application affects the amount of available nitrogen in the first year, the amounts available in subsequent years are not affected appreciably. No adjustment should be made for the long-term effect of poultry manure because most of the available nitrogen it contains is released in the year of application.

MANURE ANALYSIS

The nutrient content of manure varies not only with the type of livestock but with their age, the ration fed, the type of bedding, and amount of water added and the method of storing the manure. Chemical analyses will indicate more accurately than this publica' on the amount of nutrients available for crop production from the particular manure you intend to use, provided a representative sample can be obtained. A manure analysis may be obtained from several labs in Ontario.

ADJUSTMENT OF NITROGEN REQUIREMENT FOR THE VALUE OF CATTLE OR SWINE MANURE APPLIED IN PREVIOUS YEARS

Rate of Manure Application Solid (t/ha*)	Liquid (cubic m/ha*)	Years of Manure Application	Consecutive Reduction in Crop Nitrogen Requirement kg N/ha
20	50	5	20
20	50	10	30
40	100	3	20
40	100	5	30
40	100	10	30

* *66 bu manure = 1 metric tonne approximately. 10 tonne/ha = 4.5 tons/ac. One m^3 = 220 Imperial gallons. One m^3/ha = 90 gal/ac.*

SOIL TESTING

Before planting any crop get a soil test. Soil tests give you information on the nutrient elements available in soil but cannot tell the suitability of a soil for a specific crop.

The soil test can:

1. indicate the kind and amount of lime required;
2. measure the soil nutrients available for crop production;
3. provide the basis for suggested rates for fertilizer applications.

Soil testing is currently by far the most accurate tool available in Ontario to determine the amounts of phosphorus, potassium and magnesium fertilizers and lime which should be applied to crops.

OTHER METHODS OF ASSESSING NUTRIENT NEEDS

1. Plant analysis is the main tool used for tree fruits and can serve as additional information supporting the soil test for field and vegetable crops.

2. Nutrient deficiency symptoms on crop leaves are helpful in some cases but have serious drawbacks in others, particularly with potassium and phosphorus.
3. It is occasionally suggested that a farmer apply the amounts of nutrients removed by the crop. This has some application for nitrogen as, with some crops, the suggested rate approximates what the plant removes. It has little relevance for other nutrients in Ontario. Many of our clay and clay loam soils have sufficient potassium to last for many years, and application of potassium each year on those soils is a waste of money and ignores one of the few advantages which clay soils have over coarser-textured soils.

To determine your fertilizer requirements for a specific crop on a specific field, the soil testing program is the main guide, with some help from plant analysis and nutrient deficiency symptoms.

ANALYSES AVAILABLE THROUGH THE OMAF SOIL TESTING SERVICE AT AGRI-FOOD LABORATORIES, 503 IMPERIAL ROAD, UNIT 1, GUELPH, ONTARIO N1H 6T9

MATERIALS	WHAT IS ANALYZED	COST PER SAMPLE
1. Field Soils	Plant-available Phosphorus, Potassium, Magnesium; pH; Lime requirement; Calcium (on tobacco soils only)	No Charge
2. Home Garden and Lawn Soils	Plant-available Phosphorus Potassium, Magnesium; pH; Lime requirement	$7.00
3. Commercial Turf Soils	Plant-available Phosphorus, Potassium, Magnesium; pH; Lime requirement	No Charge
4. Greenhouse Media, Water* and Nutrient Solutions*	Plant-available Nitrogen, Phosphorus, Potassium, Calcium, Magnesium; pH; Sulfates; Chlorides; Total Salts	No Charge
5. All Soils (optional, on request only)	Plant-available Manganese and Zinc	$2.00
6. All Soils (optional, on request only)	Organic Matter	$5.00

**Laboratory requires 500 mL sample.*

WHAT DOES THE OMAF SOIL TESTING PROGRAM PROVIDE FOR THE FARMER?

The soil testing program provides recommendations for nitrogen, phosphate, potash and magnesium fertilizer, along with recommendations for the amount and type of lime you should apply. These recommendations are expected to produce maximum yields under recommended management methods. Some fertilizer is recommended at soil test levels slightly above those where crop response is profitable. This is done: (a) for maintenance (to maintain high soil-nutrient levels); and, (b) to allow for some error in sampling the field.

No soil test is available which is satisfactory for nitrogen under Ontario conditions. The nitrogen recommendations for different crops on mineral and muck soils are compilations from all of the research experience in Ontario.

The phosphate and potash requirements for different crops are presented on pages 26 and 27. These recommendations and the soil tests on which they are based are approved by the Ontario Soil Management Research Committee.

Where a recent soil test is not available, a rough estimate of fertilizer requirements can be obtained from the tables on pages 26 and 27, using the following guidelines:

a. Where the field has been fertilized regularly for a number of years or heavily in recent years, use one of the rates of phosphate and potash recommended for the **medium** soil-test rating;
b. If the field has received little fertilizer in the past, use one of the rates recommended for the **low** soil-test rating. Some clay and clay loam soils are naturally high in potassium and do not require any potash fertilizer. Only a soil test can adequately determine potash requirements.

MICRONUTRIENT TESTS

Manganese and zinc tests are provided by the OMAF service. In the case of zinc on corn, the soil test is best used in conjunction with visual deficiency symptoms. With manganese, plant analysis, visual symptoms and the soil test are all useful. The OMAF service does not provide a soil test for boron, copper or iron. Tests for these elements range from rather unreliable in the case of boron to useless in the case of copper on Ontario soils. Plant analysis and visual symptoms are useful for determining boron and copper needs.

SOIL TESTS FROM OTHER LABORATORIES

Each year a number of growers ask OMAF staff to interpret soil test results from other laboratories. Provided the other laboratory

uses the identical chemical tests used in the OMAF laboratory and expresses their test results in the same units, the OMAF fertilizer requirements for phosphorus and potash can be applied. However, it is rare that this is the case.

Only soil tests using chemical extractants which have been calibrated by a number of field experiments on Ontario soils can be relied on to provide accurate fertilizer recommendations. Be certain that the service you are using measures up to these standards.

A number of laboratories provide tests such as exchange capacity, aluminum and copper. These are not provided by the OMAF service because they have not been found to contribute to better fertilizer recommendations. Research has shown that on Ontario soils use of exchange capacity to adjust potash recommendations can lead to less reliable recommendations than are now provided.

SOIL SAMPLING

Soils may be sampled with a sampling tube or with a shovel. Each field, or uniform section of a field, should be sampled separately. At least 20 soil cores 15 cm deep should be taken from any field or area sampled up to 5 ha in size. For fields larger than 5 ha, proportionately more cores should be taken. The more cores taken, the more likely the soil sample will provide a reliable measure of the fertility in the field. The soil can be collected in a clean pail, the lumps should be broken, the soil mixed well, and a soil sample box forwarded for testing. The area sampled should be traversed in a zigzag pattern to provide a uniform distribution of sampling sites. One sample should not represent more than 10 hectares. Parts of a field that differ in appearance of soil or crop, in previous fertilization, manuring or liming should be sampled separately even if they are too small to fertilize separately. Avoid sampling recent fertilizer bands, dead furrows, areas adjacent to gravel roads or where lime manure compost or crop residues have been piled.

WHEN TO SAMPLE

Each field should be sampled once every two to three years. Potash levels can change quickly where large amounts of nutrients are removed from sandy soils (for example, with crops such as potatoes or tomatoes) and manure is not returned. Under these conditions samples should be taken each year.

The results of soil tests are forwarded to the grower, and a copy sent to the county or district office of the Ontario Ministry of Agriculture and Food, within 5 working days of receipt of samples in the laboratory. However, to allow time for mailing and analysis, soil samples from fields to be fertilized for spring-seeded crops should be taken the previous fall. Because of the rush of harvest and the frequency of poor weather late in the fall, summer may be a more convenient time to sample.

SAMPLE BOXES AND INFORMATION SHEETS

Soil sample boxes and information sheets may be obtained from any district or county office of the Ontario Ministry of Agriculture and Food or from Agri-Food Laboratories, Unit 1, 503 Imperial Road, Guelph, Ontario N1H 6T9.

Management practices which affect a soil test recommendation are manure application, legume sod plowed down, and the crop to be fertilized. This information is essential for a reliable fertilizer recommendation, and should be recorded on the field information sheet which must accompany the soil sample sent in for analysis.

CHANGES IN CROP OR MANAGEMENT

Fertilizer requirements on the OMAF soil test report are for specific crops and management. If the crop management is changed in regard to legumes plowed down or manure applied, then adjustments in fertilizer requirements may be made using the manure and legume-sod adjustments in the table below and on page 16. If the crop is changed from that for which the recommendation was made, a new recommendation can be obtained by looking up the appropriate table under the specific crop section in this publication.

NITROGEN ADJUSTMENT FOR LEGUMES PLOWED DOWN

When sod containing legumes such as alfalfa, trefoil and clover is plowed under, it supplies an appreciable amount of nitrogen to the following crop. The table below shows reductions which should be made in nitrogen fertilizer applications to crops following sod containing legumes.

ADJUSTMENT OF NITROGEN REQUIREMENT WHERE SOD CONTAINING LEGUMES IS PLOWED DOWN

Type of Sod	For all Crops Deduct from N Requirement kg N/ha
Less than 1/3	0
1/3 to 1/2 legume	22
1/2 or more legume	110
Perennial legumes seeded and plowed the same year	45[1]

[1] *Applies where the legume stand is thick and over 40 cm high*

PLANT ANALYSIS

Plant analysis measures the nutrient content of plant tissue. Comparing the results against the "normal" and "critical" values for the crop can indicate whether the nutrient supply is adequate for optimum growth.

Plant analysis is a useful supplement to soil testing for evaluation of the fertility status of crops. It is quite independent of soil testing and can provide a valuable "second opinion", especially for phosphorus, potassium, magnesium and manganese. For nitrogen and zinc it has not been very reliable. For boron and copper we don't have a reliable soil test, so plant analysis and visual symptoms are the only methods for diagnosing deficiencies.

Plant analysis has limitations. Expert help in interpreting the results is often needed, since plant analysis does not always indicate the cause of a deficiency or the amount of fertilizer required to correct it.

SAMPLING

Time of sampling has a major effect on the results, since nutrient levels with a plant vary considerably with its age. Results are difficult to interpret if samples are taken at times other than those recommended. Nevertheless, plants suspected of being nutrient deficient should be sampled as soon as a problem appears. Samples are best taken from a problem area rather than from the entire field.

Samples for plant analysis should be taken from at least 20 plants distributed throughout the area chosen for sampling. Each sample

should consist of at least 30 grams of fresh material. Problem areas should be sampled separately. When taking samples for plant analysis, take care not to contaminate the sample with soil. Even a small amount of soil will cause the results to be invalid, especially for micronutrients.

SAMPLE PREPARATION

Samples of fresh plant material should be delivered directly to the laboratory. If they are not delivered immediately, they should be dried to prevent spoilage. Samples may be dried in an oven at 65°C or less, or dried in the sun provided precautions are taken to prevent contamination with dust or soil. Avoid contact of samples with galvanized (zinc-coated) metal, brass or copper.

Plant analyses may be obtained from several laboratories in Ontario.

SEWAGE SLUDGE

Land may not be used to grow vegetables within six months after sludge applications. This avoids the potential hazards associated with the presence of pathogens and, in particular, of parasitic organisms.

SOIL ACIDITY AND LIMING

The pH scale ranging from 0 to 14 is used to indicate acidity and alkalinity. A pH value of 7.0 is neutral; values below 7.0 are acid and those above 7.0 are alkaline. Most vegetable crops grow well in a soil pH range from 6.0 to 7.5 on mineral soils and from 5.0 to 6.0 on muck soils. Many vegetable crops grow well on mineral soils above pH 7.5 but micronutrient deficiences are more likely.

To correct soil acidity, ground limestone should be broadcast and worked into the soil at rates determined by soil test. The accompanying table shows the soil pH values below which lime is recommended and the "target" soil pH to which soils should be limed for different crops. In Ontario most crops grow quite well at pH values higher than the target pH to which lime is recommended.

THE BUFFER pH

Different soils with any one soil pH value, say 5.2, will require different amounts of lime to bring the pH to a particular desired level, say 6.0, depending chiefly on the clay and organic matter content of each soil. The soil pH is used to determine which soils need to be limed, but a separate soil test, the buffer pH, is used on soils needing lime to determine the amount of lime required. For soils needing lime (based on soil pH), use the Lime Requirement Table to determine the amount of lime required to reach different "target" soil pH values required for different crops.

SOIL pH AT WHICH LIME IS RECOMMENDED FOR ONTARIO CROPS

Crops	Soil pH Below Which Lime is Recommended	Target Soil pH*
Coarse-and Medium-Textured Mineral Soils (sands, sandy loams, loams and silt loams)		
All crops not listed below	6.1	6.5
Corn, soybeans, winter rye, grass hay and pasture, turf, tobacco	5.6	6.0
Potatoes	5.1	5.5
Fine-Textured Mineral Soils (clays and clay loams)		
Alfalfa, cole crops, rutabagas	6.1	6.5
All crops not listed above or below	5.6	6.0
Corn, rye, grass hay and pasture, tobacco	5.1	5.5
Organic Soils (peats and mucks)		
All field and vegetable crops	5.1	5.5

**Where a crop is grown in rotation with other crops requiring a high pH (for example, corn in rotation with wheat or alfalfa), it is recommended that the soil be limed to the higher pH.*

LIME REQUIREMENTS TO CORRECT SOIL ACIDITY BASED ON SOIL pH AND SOIL BUFFER pH

Buffer pH	Target Soil* pH = 7.0	Target Soil pH = 6.5 Lime if soil pH below 6.1	Target Soil pH = 6.0 Lime if soil pH below 5.6	Target Soil pH = 5.5 Lime if soil pH below 5.1
	Ground Limestone Required — t/ha (Based on an Agricultural Index of 75)			
7.0	2	2	1	1
6.9	3	2	1	1
6.8	3	2	1	1
6.7	4	2	2	1
6.6	5	3	2	1
6.5	6	3	2	1
6.4	7	4	3	2
6.3	8	5	3	2
6.2	10	6	4	2
6.1	11	7	5	2
6.0	13	9	6	3
5.9	14	10	7	4
5.8	16	12	8	4
5.7	18	13	9	5
5.6	20	15	11	6
5.5	20	17	12	8
5.4	20	19	14	9
5.3	20	20	15	10
5.2	20	20	17	11
5.1	20	20	19	13
5.0	20	20	20	15
4.9	20	20	20	16
4.8	20	20	20	18
4.7	20	20	20	20
4.6	20	20	20	20

**Liming to pH 7.0 is recommended only for club-root control on cole crops.*

EXAMPLE CALCULATION OF THE FINENESS RATING OF A LIMESTONE

Particle Size	% of sample		Effectiveness factor		
Coarser than No. 10 sieve*	10	x	0.0	=	0
No. 10 to No. 60 sieve	40	x	0.4	=	16
Passing through No. 60 sieve	50	x	1.0	=	50
			Fineness Rating	=	66

**A No. 10 sieve has wires spaced 2.0 mm. and a No. 60 sieve spaced 0.25 mm apart.*

LIMESTONE QUALITY

Calcitic limestone consists largely of calcium carbonate. Dolomitic limestone is a mixture of calcium and magnesium carbonates. Dolomitic limestone should be used on soils with a magnesium soil test of 100 or less, as it is an excellent inexpensive source of magnesium for acid soils. On soils with magnesium tests greater than 100, calcitic or dolomitic limestone may be used.

Two main factors effect the value of limestone for soil application. One of these is the amount of acid a given quantity of limestone will neutralize when it is totally dissolved. This is called the "neutralizing value" and is expressed as a percentage of the neutralizing value of pure calcium carbonate. A limestone which will neutralize 90% as much acid as pure calcium carbonate is said to have a neutralizing value of 90. In general, the higher the calcium and magnesium content of a limestone, the higher the neutralizing value.

The second factor which affects the value of limestone as a neutralizer of acidity is the particle size. Limestone rock has much less surface area to react with acid soil than finely powdered limestone, and hence it neutralizes acidity much more slowly — so slowly that it is of little value.

The calculation of a fineness rating for ground limestone is illustrated in the accompanying table.

THE AGRICULTURAL INDEX

Some means of combining the Neutralizing Value and the Fineness Rating is needed to compare various limestones that are available. The index which has been developed in Ontario to do this is called the "Agricultural Index".

$$\text{The Agricultural Index} = \frac{\text{neutralizing value x fineness rating}}{100}$$

The Agricultural Index can be used to compare the relative value of different limestones for neutralization of soil acidity[1]. Lime with a high Agricultural Index is worth proportionately more than lime with a low index because it may be applied at a lower rate. If two ground limestones, A and B, have Agricultural Indices of 50 and 80 respectively, the rate of application of limestone A required for a particular soil will be 80/50 x the rate required for limestone B. Limestone A spread on your farm is worth 50/80 x the price of limestone B per tonne.

Recommendations from the Ontario soil test service are based on limestone with an Agricultural Index of 75. If you know the Agricultural Index, you can calculate a rate of application specifically for limestone of that quality. This can be done using the following equation:

$$\text{Limestone application rate from soil test report} \times \frac{75}{\text{Agri. Index of your limestone}} = \text{Rate of application of your limestone}$$

For example, if you have a limestone requirement by soil test of 9 t/ha, and your most suitable source of limestone from a quality and price standpoint has an Agricultural Index of 90, you should apply 9 x 75/90 = 7.5 t/ha.

[1] *The Agricultural Index does not provide information about magnesium content. Dolomitic limestone should be used on soils low in magnesium.*

LIQUID LIME

"Liquid lime" is advertised and occasionally sold in Ontario, often at very high costs in relation to the neutralizing value. This is very fine ground limestone suspended in water. It is equivalent to finely ground dry lime in availability and would have a "fineness" rating of 100. When diluted with water neutralizing value will be low per unit of weight, resulting in the need for high rates of application. Note that in the fineness rating lime passing through a 60 mesh screen is considered to be 100% effective. Limestone ground finer than this is not considered to be any more effective.

TILLAGE DEPTH

Lime recommendations presented here should raise the pH of the top 15 cm (6 inches) of a soil to the listed target pH. If the soil is ploughed to a greater depth than 15 cm, proportionately more lime is required to reach the same target pH. Since lime moves very slowly in soils, it should be incorporated to 15 cm depth where practical.

LOWERING SOIL pH

On soils with pH values below 7.0 it is possible to lower the pH (make the soil more acid) by adding sulfur or aluminum sulfate. If the soil pH is above 7.0, it is not advisable and also usually quite impractical to lower the soil pH because of the very large amounts of sulfur or aluminum sulfate required.

SOIL ACIDIFICATION TO pH 5.0 WITH SULFUR

	Soil Type			
Initial pH	**Sand**	**Sandy loam**	**Loam**	**Clay loam**
7.0	9*	11	14	17
6.5	8	9	11	14
6.0	6	7	8	11
5.5	3	4	5	8

**kg of elemental sulfur per 100 m² for 2 successive years*

FERTILIZER ANALYSES AND BLENDS

The Ontario Soil Management Research Committee recommends fertilizers on the basis of the nutrient requirements shown by research and soil tests. In some situations traditional fertilizer ratios will meet the combined requirements for nitrogen, phosphate and potash. Most fertilizer dealers can produce blends which meet the needs of the crop, as indicated by soil tests.

FERTILIZER MATERIALS

Nitrogen fertilizers are available in dry, liquid and gaseous forms. Which of these forms to use is a matter of choice for the individual vegetable grower, depending upon availability of the material, equipment for handling, cost per kilogram of nitrogen, the cost of application and grower preference.

Where separate additions of nitrogen are referred to in the recommendations, kilograms of elemental nitrogen, not kilograms of materials, are used. The table on page 22 shows the percentage of fertilizer nutrient contained in different materials.

TOXICITY OF FERTILIZER MATERIALS

All fertilizer salts are toxic to germinating seeds and to plant roots if applied in sufficient concentration near the seed. Fertilizers vary in toxicity per unit of plant nutrient due to: (1) differences in the amount of salts contained in the fertilizer per unit of plant nutrient; (2) differences in solubility of the salts in the soil; and (3) a few specific materials or elements are particularly toxic (for example, anhydrous ammonia or boron). Phosphate fertilizers are usually low in toxicity because a large portion of the phosphate is precipitated in the soil before it can reach the plant roots. The concentration of phosphorus in the soil solution at any one time is very low.

NUTRIENTS IN FERTILIZER MATERIALS

Nitrogen Materials	Form	% Nitrogen (N)*
Ammonium nitrate	Dry	33 to 34
Urea	Dry	45 to 46
Ammonium sulfate	Dry	20
Aqua ammonia	Liquid**	20
Ammonium nitrate-urea (UAN)	Liquid	28
Ammonium nitrate-urea (UAN)	Liquid	32
Ammonia-ammonium nitrate-urea	Liquid**	41
Ammonia-ammonium nitrate	Liquid**	41
Anhydrous ammonia	Liquid**	82
Phosphate Materials	**% Phosphate (P_2O_5)***	
Superphosphate	18 to 20	
Triple superphosphate	44 to 46	
Monoammonium phosphate (MAP)	48 to 52	
Diammonium phosphate (DAP) 18-46-0	46	
Potash Materials	**% Potash (K_2O)***	
Muriate of potash	60	
Sulfate of potash	50	
Sulfate of potash-magnesia (11% Mg)	22	
Potassium nitrate (13-0-44)	44	

* *Kilograms of N, P_2O_5 or K_2 supplied in 100 kilograms of materials.*
***Liquid under pressure.*

SOLUBLE SALTS IN FARM SOILS

High concentrations of water soluble salts in soils can prevent or delay germination of seeds and can kill established plants or seriously retard their growth.

Ontario soils are naturally low in soluble salts. Soluble salts therefore rarely cause a problem in crop production and are not routinely measured in soil tests.

Soluble salts in soils can result from excessive applications of fertilizers and manures, runoff of salts applied to roads, and chemical spills on farm land. High concentrations of soluble salts in or near a fertilizer band can cause serious temporary problems, affecting seed germination and/or early plant growth without seriously affecting the salt concentrations in the remainder of the soil. A given amount of salt in a soil provides a higher salt concentration in soil water if the amount of water is small. Soluble salts also interfere with the uptake of water by plants. For these reasons plant growth is most affected by soluble salts in periods of low moisture supply (during drought periods).

Soluble salts can be measured readily in the laboratory by measuring the electrical conductivity of a soil water slurry. The higher the concentration of water soluble salts, the higher the conductivity. The following table provides an interpretation of soil conductivity readings as read in Ontario field soils in a 2:1 water: soil paste, the procedure used by the OMAF soil testing service.

Soil Conductivity Reading Interpretation

Conductivity "salt" reading millisiemens/cm	Rating	Plant Response
0-0.25	L	Suitable for most plants if recommended amounts of fertilizer are used.
0.26-0.45	M	Suitable for most plants if recommended amounts of fertilizer are used.
0.46-0.70	H	May reduce emergence and cause slight to severe damage to salt-sensitive plants.
0.71-1.00	E	May prevent emergence and cause slight to severe damage to most plants.
1.00	E	Expected to cause severe damage to most plants.

For greenhouse soils, the OMAF soil test uses a larger soil sample and measures conductivity on a saturation extract. For greenhouse crops using that method, conductivity readings up to 3.5 millisiemens/cm are acceptable.

1. **Nitrogen Fertilizers**

   Ammonium nitrate, monoammonium phosphate and ammonium sulfate are similar in toxicity and much safer than anhydrous ammonia, aqua ammonia or urea.

   Diammonium phosphate is more toxic than monoammonium phosphate but less toxic than urea. More care should be taken, particularly with sensitive seeds and on coarse-textured soil (sand and sandy loam), than is required with ammonium nitrate, or monoammonium phosphate.

   Anhydrous ammonia and aqua ammonia are extremely toxic fertilizers and should not be applied near seeds unless applied at least one week before seeding. Urea is toxic when banded with or near the seed but is safe when broadcast at rates normally used. Fertilizers containing more than half as much nitrogen as phosphate frequently contain urea.

2. **Phosphate Fertilizers**

   Most common phosphate fertilizers are not very toxic to seeds and plants and no limit is normally set for the safe rate which may be applied with, or near, the seed of vegetable crops.

   Diammonium phosphate is more toxic than other phosphate fertilizers — see under nitrogen fertilizers.

3. **Potash Fertilizers**

   Muriate of potash (KCl) is the most common source of potassium in fertilizers, and is less toxic per unit of plant nutrients than most nitrogen fertilizers.

   Sulfate of potash (K_2SO_4) is less toxic than muriate of potash.

   Sulfate of potash-magnesia has approximately the same toxicity per unit of potassium as muriate of potash.

   Potassium nitrate is one of the safer sources of potassium when considered as a nitrogen source as well.

4. **Fertilizers Containing Micronutrients**

   Fertilizers containing micronutrients (boron, copper, iron, manganese or zinc) are more toxic than the same grades without micronutrients, and maximum safe rates should be reduced. Boron is particularly toxic.

FERTILIZER PLACEMENT

Phosphorus is most important for early growth and is more available if placed near the seed. For transplant crops, the use of high-phosphorus starter solution is a profitable practice.

Nitrogen fertilizers readily dissolve in the soil water and move easily through the soil to the plant roots. Placement of nitrogen is less important than for phosphorus. Part of the nitrogen requirements is usually broadcast, injected or worked into the soil before planting, often to hasten the breakdown of the cover crop. Much of the nitrogen is not applied until side-dressing in order to conserve the fertilizer from leaching or to restrain plants from too much vegetative growth.

Too much potassium applied in a band at planting or in the transplant water can injure young seedlings and reduce crop yield and quality. This danger of fertilizer injury is greater on sands and sandy loams than on silt loam and clay loam soils. On the coarse-textured sands and sandy loams, part of the potassium fertilizer requirements should be broadcast and worked into the soil before planting.

STARTER SOLUTIONS

Water-soluble fertilizers (e.g., 10-52-10) and liquid fertilizers (e.g., 6-24-6 and 10-34-0) are used as starter solutions at planting time to stimulate the growth of young transplants.

Vegetable crops will benefit if starter solutions are used in the planting water when the young transplants are set in the field.

SIDE-DRESSING

The purpose of side-dressing is to supply additional nutrients during growth of the crop. Most commonly, nitrogen is the nutrient that is supplied after the plant has reached a certain stage of development. With crops that produce fruit (e.g., peppers or tomatoes), it is important not to have too much vegetative growth early in the season, or flowers will not develop, or may drop off if they do develop. For this reason, it is usually advisable to put only a moderate amount of nitrogen in the soil at the time of seeding or planting. After the plant has set some fruit and is no longer in danger of becoming too vegetative, extra nitrogen can be applied. The timing and amount of nitrogen side-dressing must be judged from the appearance of the plants. On coarse, sandy soil it may be advisable to add potash as well as nitrogen.

FERTILIZER THROUGH THE IRRIGATION SYSTEM

Many fertilizers, particularly nitrogen, may be applied through the irrigation system during the growing season. In some crops it is difficult to move along the rows with side-dressing machinery without damaging the plants, whereas the irrigation water will penetrate fairly evenly over the whole area without damaging the plants. Additional information is given on page 28 under Irrigation.

SOIL MAGNESIUM

Magnesium is a plant nutrient which is naturally plentiful in many Ontario soils. Soils with magnesium soil tests below 20 (OMAF soil test) require magnesium application for production of most crops. Very few Ontario soils have magnesium tests below 20. If the soil pH is 6.0 or lower, the most effective means of supplying magnesium is by application of dolomitic limestone. If the pH is above 6.0, magnesium can be supplied by either magnesium sulfate or sulfate of potash-magnesia. These latter sources of magnesium are usually quite expensive compared to supplying magnesium from dolomitic limestone.

Potassium competes with magnesium for uptake by crops, and potash applications can therefore induce or increase magnesium deficiency. For this reason, it is important to monitor soil potassium levels and to carefully control potash fertilizer applications on low-magnesium soils.

A magnesium deficiency may occur on carrots, celery, tomatoes and spinach. The usual symptom is yellowing of the older leaves while the veins remain dark green. Magnesium deficiency in celery may be caused by a genetic abnormality in which the plant is unable to obtain magnesium from the soil. Potato plants become lighter in colour.

MICRONUTRIENTS

Micronutrient elements should not be combined with insecticide or fungicide sprays unless the manufacturer's directions indicate that this may be done or experience has shown they are compatible.

Micronutrient elements should be applied only on competent advice or where experience has proven their application to be necessary. Soil or foliar applications can be made. Soil applications are generally made at soil-preparation time and foliar applications are applied during the growing season. A sticker spreader should be included in micronutrient sprays.

Boron. A lack of boron causes a breakdown of the young tissue with slow growth, tissue cracking, blackening, and misshapen plants. In addition, the leaves of beets and spinach become twisted with light spots on the petioles. Internal breakdown (internal black spot) may occur in the roots or may appear on the root surface as external cankers. Broccoli and cauliflower show leaf rolling and deformed buds, hollow stems, and the heads turn brown. Cabbage develops internal dead spots and hollow stems. Corn kernels fail to develop at the tip of the cob and the ears are barren. Celery petioles show reddish-brown spots (cat-scratches). Rutabagas develop water-soaked areas (water-core) internally.

Because boron is needed only in very small quantities, and since an overdose is toxic, extreme care should be taken in its use. Continued applications should be made only on expert advice. Application of boron to mineral soils has not been universally successful; foliar sprays have generally given faster and more effective results. Spray when the young plants are about 8 cm high. A second application may be required. On request, boron fertilizers may be mixed with ordinary fertilizers by manufacturers.

Copper. Copper-deficient lettuce leaves lose their firmness (rabbit-ear), become chlorotic, and the plants become bleached on the stems and leaf margins. Onions produce thin, pale yellow scales which cause poor colour and keeping quality. A lack of copper also causes poor colour in carrots.

Copper deficiency seldom occurs in the mineral soils of Ontario; however, copper sulfate should be used for at least three years on new muck soils. Further applications should be made as suggested by experience and experimental evidence.

Soil-applied fertilizer copper has recently been shown to have the residual effect of slowing down the undesirably rapid degradation and subsidence of cultivated muck soils (see page 15).

Extreme care is necessary using foliar sprays with copper sulfate, because injury to the foliage may occur readily. Competent advice in the use of copper sprays is necessary.

Manganese. The general symptoms of manganese deficiency are interveinal chlorosis of leaves which begins in the younger foliage. Later the whole plant may be affected. A russetting, curling and dwarfing of the foliage occurs in beets. Other crops susceptible to manganese deficiency are beans, carrots, onions, celery, and tomatoes. Spray applications have proven more effective than soil applications. Apply sprays when the plants are about one-third grown, or sooner if this deficiency is identified. Two or more sprays may be necessary at 10-day intervals to correct the deficiency.

Molybdenum. Deficiency symptoms on cauliflower and broccoli start with cupping of the leaf margins and interveinal chlorosis of the younger leaves. As the leaves develop, twisting of the midrib and irregular development of the leaf tissue cause a strap- or whip-like appearance (whiptail). The early symptoms of molybdenum deficiency in other crops are similar to nitrogen deficiency. Later symptoms are interveinal mottling of leaves with chlorotic areas becoming puffy, marginal cupping and scorching of leaves, twisting and distortion of younger leaves.

This deficiency occurs more often on sandy, acid soils; however, it may occur even in neutral soils if soil-molybdenum reserves are depleted by heavy cropping. Molybdenum availability to plants increases with an increase in pH, and differs from the other trace elements. Consequently, liming acid soil may be a good practice to overcome molybdenum deficiency. Molybdenum can also be applied in the transplanting water at the rate of 30 to 40 g of sodium molybdate per 100 L of water, each plant receiving 0.3 L of this solution.

SECONDARY AND MICRONUTRIENT RECOMMENDATIONS

The following secondary and micronutrients may be deficient on some Ontario soils. To prevent foliar sprays from being toxic to the plant, do not exceed the recommended concentration. The spray should be sufficient to wet the foliage. In some cases more than one application may be necessary.

	APPLICATION RATE					
	Soil*			%	Foliar	
Nutrient	Nutrient kg/ha	Product kg/ha	Source	Composition	Nutrient kg per 1000 L	Product kg per 1000 L
Calcium (Ca)**	—	—	Calcium Chloride	36% Ca	1.9	5.0
	—	—	Calcium Nitrate	19% Ca	1.9	10.0
Magnesium (Mg)	120-260	2 t/ha	Dolomitic Limestone	6-13% Mg	—	—
	30	300	Epsom Salts	10.5% Mg	1.9	18
	30		Sulphate of Potash-Magnesia	11% Mg	—	—
Boron (B)	1.0-3.0		Various Materials Available	12-14.3% B	—	—
			Solubor	20% B	0.1-0.3	0.5-1.5
Copper (Cu)	7.0-14.5	28-60	Copper Sulfate	25% Cu	0.5-1.5	4-12
	—	—	Copper Chelates	5-13% Cu	0.5-1.5	—
Manganese (Mn)***	—	—	Manganese Sulfate	28% Mn	0.5-1.0	1.8-3.6
	—	—	Manganese Chelates	5-12% Mn	0.5-1.0	—
Molybdenum (Mo)	—	—	Sodium Molybdate	39% Mo	0.1-0.25	0.25-0.6
Zinc (Zn)	4-12	11-33	Zinc Sulfate	36% Zn	0.6	1.6
	4-12	—	Zinc Oxysulfate	18-36% Zn	—	—
	—	—	Zinc Chelate	9-14% Zn	0.6	—

**Double rates for muck soil, except dolomitic limestone.*
***For blackheart of celery.*
****For onions use 1.5 to 2.75 kg Mn/1000 L.*

CAUTIONS

(1) Because of the danger of burning leaf tissue, do not mix more than one micronutrient at a time. Do not spray under hot, humid conditions. It is very rare that more than one micronutrient is deficient at one time.

(2) Do not spray less than 200 litres per hectare.

(3) Micronutrient chelates are generally no more effective than water soluble inorganic sources when used as a foliar spray. Be sure you use enough. If sufficient quantity is used to be effective, the cost is quite high.

PHOSPHORUS REQUIREMENTS — VEGETABLES ON *MINERAL* SOILS — PHOSPHATE (P_2O_5) REQUIRED — kg/ha

Phosphorus Soil Test ppm P in soil	Rating	Beans (lima) Beans (snap) Peas	Radish	Sweet corn Established asparagus	Beet Carrot Lettuce Onion Parsnip Rutabaga Spinach	Potato	Cucumber Muskmelon Pumpkin Squash Tomato* Watermelon	Celery Rhubarb	Broccoli* Brussels sprouts** Cabbage** Cauliflower** Eggplant* Pepper* Asparagus (nursery and new plantings)
0-3		80	80	110	180	200	230	230	270
4-5		60	70	100	170	200	230	230	260
6-7	LOW	50	60	90	170	190	220	220	250
8-9		40	60	70	160	190	220	220	240
10-12		30	50	50	160	180	210	220	230
13-15	MEDIUM	20	50	20	150	170	190	210	220
16-20		0	40	20	140	160	170	190	200
21-25	HIGH	0	40	0	120	140	140	160	170
26-30		0	30	0	100	120	110	140	140
31-40		0	30	0	80	90	80	110	110
41-50	VERY HIGH	0	20	0	50	50	50	80	80
51-60		0	0	0	30	30	30	50	50
61-80		0	0	0	0	30	0	0	0
80+	EXCESSIVE	0	0	0	0	30	0	0	0

* *For transplanted tomatoes, peppers and eggplants, apply a starter solution, such as 1 L of 10-34-0 per 100 L water, or 1 L of 6-24-6 per 75 L at planting.*

For transplanted broccoli, Brussels sprouts, cabbage and cauliflower, if no insecticide is used in the planting water, apply a starter solution high in nitrogen such as 20-20-20 at 1 kg/200 L. Under high temperatures and in dry, sandy soils use half the concentration of fertilizer.

The fertilizer rates in this table are designed to produce highest economic yields when accompanied by good or above-average management.

POTASSIUM REQUIREMENTS — VEGETABLES ON *MINERAL* SOILS — POTASH (K_2O) REQUIRED — kg/ha

Potassium Soil Test ppm K in soil	Rating	Radish Beans (lima) Beans (snap) Peas	Sweet corn	Cucumber Muskmelon Pumpkin Squash Watermelon	Beet Carrot Lettuce Onion Parsnip Potato Spinach	Broccoli Brussels sprouts Cabbage Cauliflower Eggplant Pepper	Celery Rhubarb Rutabaga*	All Asparagus	All Tomatoes*
0.15		60	120	170	230	230	270	340	420	660
16-30		60	110	160	220	220	250	330	400	640
31-45	LOW	50	90	140	200	210	230	310	360	600
46-60		50	80	110	180	190	200	280	320	560
61-80		40	60	60	140	160	170	250	280	480
81-100		30	40	40	100	130	130	200	250	400
101-120	MEDIUM	30	30	30	70	100	100	150	220	340
121-150		20	0	0	50	80	80	90	190	300
151-180		20	0	0	40	50	50	50	160	280
181-210	HIGH	0	0	0	0	0	0	0	130	140
211-250	VERY HIGH	0	0	0	0	0	0	0	80	70
250+	EXCESSIVE	0	0	0	0	0	0	0	0	0

* *For rutabagas and tomatoes on soils with magnesium tests less than 100, the required amount of potash is adjusted downward from the amounts shown in this table to a minimum of 50% at 50 ppm Mg.*

The fertilizer rates in this table are designed to produce highest economic yields when accompanied by good or above-average management.

PHOSPHORUS AND POTASSIUM REQUIREMENTS — VEGETABLES ON *MUCK* SOILS

Phosphorus Soil Test	Rating	Beet, Broccoli, Brussels sprouts, Cabbage, Carrot, Cauliflower, Lettuce, Onion*, Parsnip, Potato, Radish, Spinach	Celery
ppm P in soil		Phosphate (P_2O_5) required kg/ha	
0-3		100	120
4-5		100	120
6-7	LOW	100	120
8-9		100	120
10-12		90	120
13-15		90	110
16-20	MEDIUM	80	100
21-25		70	90
26-30		60	80
31-40		50	70
41-50	HIGH	30	50
51-60	VERY HIGH	20	40
61-80		0	0
80+	EXCESSIVE	0	0

Potassium Soil Test	Rating	Broccoli · Brussels sprouts Cabbage Cauliflower	Carrot Celery Onion Parsnip Potato	Beet Lettuce Radish Spinach
ppm K in soil		Potash (K_2O) required — kg/ha		
0-15		200	230	100
16-30		190	220	100
31-45	LOW	170	210	90
46-60		150	200	80
61-80		120	170	60
80-100		90	150	40
101-120	MEDIUM	70	120	30
121-150		50	80	20
151-180		40	40	20
181-210	HIGH	0	0	0
211-250	VERY HIGH	0	0	0
250+	EXCESSIVE	0	0	0

** If maturity of onions is a problem on organic soils less than 40 cm deep, additional phosphate may be required.*

The fertilizer rates in this table are designed to produce highest economic yields when accompanied by good or above-average management.

CROP ROTATION FOR CONTROL OF DISEASES

Crop rotation is an important method for controlling certain fungi, bacteria and nematodes that cause plant diseases. The disease organisms that are controlled by a rotation will persist only for a short time (1 to 2 years) in the soil in the absence of the crops they attack. Rotation often must be combined with other controls to provide a high level of control. For example, crop rotation is important for reducing losses due to anthracnose disease in snap beans. The anthracnose fungus survives in the soil about as long as it takes for the remains of the bean plants to decompose. A rotation that includes 2 years of crops which the anthracnose fungus cannot attack is effective in "starving out" the fungus.

Like many other disease-causing organisms, the bean anthracnose fungus also survives in seeds from one season to the next. Therefore, one should sow disease-free snap bean seed to avoid bringing more of the fungus into a field that has been "cleaned up". The fungus also survives in bean straw and in trash left when beans are cleaned. So bean straw and trash should not be spread on land that is intended for snap beans during the next 2 or 3 years.

A rotation is not effective against many other organisms for a variety of reasons. The onion-smut fungus and the cabbage-yellows fungus are good examples of fungi that survive so long in the soil that a rotation is not practical. Spores of the onion-smut fungus survive for 10 to 12 years and the cabbage-yellows fungus persists indefinitely.

Powdery-mildew fungi are examples of fungi that have wind-borne spores that are blown from neighboring fields and farms. Many of the viruses that cause disease in vegetables are spread by aphids wherever they fly, and the mycoplasma that causes aster yellows in carrot, celery and lettuce is spread about by leafhoppers — regardless of rotation.

HANDY METRIC CONVERSION FACTOR

Litres per hectare x 0.4 = litres per acre
Kilograms per hectare x 0.4 = kilograms per acre

GROWTH REGULATORS

Chemical growth regulators are recommended and used to effectively control certain plant-growth processes, and thus aid crop production and storage. When used at different rates and different stages of crop growth, they modify various stages of plant growth from germination to fruit ripening, and also the storage of harvested products. Thus, it is important to apply the recommended rate at a precise stage of crop growth. Growth regulators are presently used in forcing rhubarb, for ripening of tomatoes, and for sprout inhibition in stored beets, carrots, onions and potatoes. **Read the label carefully before using any growth regulator.**

IRRIGATION

Most vegetable crops require a uniform supply of moisture throughout the growing season. The average rainfall in Ontario is 70 mm per month during the growing season. This provides only 65% of the needed water for best yield. Irrigation is as important a consideration as cultivar, fertilizer or pest control in producing good yields.

Water available for crop growth depends upon the soil's ability to retain water following rainfall or irrigation. Sands and coarse sandy loams retain less than 25 mm of water in the top 30 cm of soil, or a supply for no more than 7 days of crop growth. On these soils a weekly schedule of 25 mm of water from rainfall or irrigation maintains high crop yields. Heavier applications of irrigation water waste fertilizer by leaching nutrients from the root zone. Excessive irrigation may cause crop injury by moving herbicides from the soil surface to crop roots.

Fine sandy loams and silty loams retain 40 to 60 mm of water for crop growth. On these soils heavier and less frequent irrigations improve crop yield. Irrigations can be scheduled every 10 to 14 days at rates that provide a total of 40 to 50 mm of rainfall or irrigation.

Shallow-rooted crops respond most to irrigation. Potatoes and celery, for example, are shallow rooted and need adequate soil moisture for continuous growth. Early potatoes grown on sandy loams require 25 mm of rain or irrigation water at tuber set until harvest for best yields. Celery grown on sandy loams needs a similar weekly schedule of irrigation.

Shallow-rooted vegetables with a slightly lower but continuous need for adequate soil moisture are lettuce, onion, late potatoes, spinach, cabbage and cauliflower. Some deep-rooted crops such as carrots and beets, when grown on mineral soils, respond to heavier but less frequent irrigation with increased quality and yield.

Other vegetable crops have stages of growth when irrigation is most effectively used: beans — during and immediately after flowering; sweet corn — just before and during silking; tomatoes — during early fruit sizing; cucumber — after seeding and during fruit production. Crop symptoms of inadequate water during a critical period of crop growth are flower and fruit drop, blossom-end rot of tomatoes and peppers, poorly shaped potatoes and carrots, tip burn of lettuce and splitting of cabbage. Timely irrigation can reduce or control these disorders.

Bad timing of irrigation can reduce yield. The critical period is during early root growth when frequent and light irrigation or rain results in shallow rooting. A guide for this critical period is to apply irrigation before or immediately after seeding and transplanting if the soil is dry. The application should be long enough to wet the soil thoroughly to encourage deep rooting. Herbicides must not be applied before a heavy irrigation at planting. (For more irrigation information, see **OMAF Factsheet, Irrigation of Vegetable Crops, Agdex 250/560.**)

A wide choice of sprinkler equipment is available — from simple hand-moved laterals to labour-saving mechanized systems. The costs range from $300/ha for hand-moved laterals to $2,000 to $3,000/ha for solid-set sprinklers. These costs do not include the expenses for water supply, mains, pump or power unit.

Hand-moved laterals — The least expensive sprinkler system, priced at $300/ha with maximum use. The labour cost with this system is high in order to move the laterals through the field. Tall-growing crops are not easily irrigated. However, water distribution is uniform and the system is adapted to fields of different sizes and shapes.

Large gun or giant sprinklers — An inexpensive system at a cost of $350/ha and useful in tall-growing crops. Labour cost for moving the equipment is expensive. It has only fair uniformity of water distribution and is most affected by wind.

Solid-set — The most expensive sprinkler system at a cost of $2,000 to $3,000/ha. Little labour is required with this semi-permanent placement of lines. It is also useful for frost protection and crop cooling.

Water, tractor- and electrically-moved systems — These self-propelled systems are not common in Ontario. They are semi-permanently located to move through and irrigate large (64-hectare) fields from a central well and pump. Fields for this equipment must be large, square, fairly level and free of obstructions. Cost varies from $500 to $750/ha. Labour costs in the season are low except when the equipment is moved from one field to the next.

Boom-type sprinklers — This mechanical system is not common in Ontario. Its cost is approximately $375/ha and the labour cost for operation is high. It requires large fields and is not adaptable to hilly land. Water distribution is most affected by wind.

Irrigation systems can be used for more than just applying water to satisfy a crop's water needs. Soluble fertilizers are most effectively applied by irrigation. Application of pesticides through irrigation is not recommended but is being investigated. Water applied through low-volume sprinklers is the most effective protection against frost hazard and can, in contrast, increase crop growth during hot weather by cooling the crop.

Ammonium nitrate, ammonium sulfate, calcium nitrate, urea and soluble potassium fertilizers are effectively applied through a sprinkler system. The fertilizer is dissolved in a drum or barrel, then introduced through a valve into the irrigation line either by suction or pressure. Feed the dissolved fertilizer into the line slowly, taking 10 to 20 minutes. After all the fertilizer has passed into the line continue to irrigate for 10 to 15 minutes to flush the lines and to wash the fertilizer off the leaves. Some minor-element deficiencies can be corrected by the application of manganese, boron or copper salts through the sprinkler system. Boron deficiency is probably the most common minor-element problem in Ontario, and can be corrected by the application of 1.1 kg/ha of boron: e.g., 11 kg/ha of borax (10.6% boron) or 4.4 kg/ha of Solubor (20.5% boron).

Irrigating to cool crops during hot weather may increase crop yield. Cooling results when field heat evaporates irrigation water from crop and soil. Irrigation cooling has only recently become practical, with solid-set systems and automatic controls and valves which continually turn on and off series of sprinklers in a field. The water required for irrigation cooling is less than the amount needed for soil irrigation. Rates of 2 mm of water per hour for 2 to 3 hours are effective. Irrigation cooling is scheduled when the air temperature is 30°C or higher at noon.

NEMATODES

Root-lesion, root-knot, and sugar beet cyst nematodes are responsible for most nematode problems in Ontario vegetable crops. A crop may be attacked by the combined action of two or more kinds of nematodes. In some cases, nematodes aggravate diseases caused by fungi, (e.g. root-lesion nematodes worsen Verticillium wilt of eggplants).

The root-lesion nematode is widely distributed in Ontario and attacks many vegetable crops. It causes tiny, brownish, scratch-like wounds on the roots, and is very destructive to such crops as celery and lettuce.

The root-knot nematode is frequently found in vegetable-producing areas, particularly in muck soils and greenhouses. These nematodes cause galls on the roots, resulting in poor plant growth that quite often shows up as patchy areas in a field. Many crops are attacked by this nematode, sometimes resulting in severe losses, particularly with carrots.

The sugar beet cyst nematode is quite destructive to table beets and spinach but other root and cruciferous crops are also affected. It is frequently found in association with rhubarb. This nematode can be seen on the roots as tiny, white or brown, pearl-shaped objects.

The bulb and stem nematode, which causes onion bloat, has been reported from several of the onion-growing marshes. Onion bloat symptoms may appear early in the crop when leaves become twisted and deformed. Infected plants which survive are usually deformed, with shorter, thickened leaves. Splitting and cracking of infected bulbs is one of the most easily recognizable symptoms. Practical control measures depend largely on the limited host range of the Ontario population of this nematode as well as sanitation and soil fumigation. For additional information, see **OMAF Factsheet, Bulb and Stem Nematode, Agdex 258/628,** or your local Horticultural Crop Advisor or Pest Management Specialist.

Nematode problems are often difficult to diagnose and to control. Commercial growers are advised to consult the Horticultural Crop Advisor or Pest Management Specialist in their area if a nematode problem is suspected.

Steam sterilization of greenhouses is still a very effective means of controlling nematodes, although chemical fumigation has become a common practice with many growers.

In the field, a program of crop rotation with periodic soil fumigation is recommended. Consult your Horticultural Crop Advisor or Pest Management Specialist, or the Research Station, Agriculture Canada, at Vineland Station, concerning crop-rotation programs for individual crops. For additional information on nematode diagnosis, refer to the Factsheets listed on pages 78 and 79, etc.

The chemicals most commonly used in preplant soil fumigation for nematode control are Telone II, Telone C-17, and Vorlex Plus. In Ontario, much of the soil fumigation against nematodes is done by custom operators. Recommended dosage is usually indicated as a range, e.g., 110-220 L/ha. Use a level near the upper limit for muck soil. Always follow manufacturer's directions carefully concerning dosage and methods of use.

Soil fumigation can be done either in the fall or in the spring. Most growers prefer to fumigate in the fall to avoid delays in planting in the spring.

At the time of fumigation, the soil temperature should be at least 4°C at the 15-cm depth, the soil must be thoroughly worked to a depth of 20 to 25 cm and the moisture content of the soil must be at a level that would permit good seed germination. With fall applications, the soil should be worked several weeks before fumigation so that the area is reasonably free from undecomposed crop residue. For a copy of the publication **Land Preparation — A Key to Successful Soil Fumigation,** contact Nematology Section, Research Station, Agriculture Canada, Vineland Station L0R 2E0.

The soil surface must be sealed immediately after injection by floating, packing or a water seal, and left undisturbed for one week, or longer if the weather is wet and cool. Before planting, till the soil thoroughly to aerate, and ensure that all traces of fumigant odor have dissipated. With fall applications, the soil should not be disturbed after sealing until the normal spring cultural operations are started.

Methyl bromide, and at high dosage Vapam and Vorlex, are used as general-purpose soil fumigants. Do not use nematicides containing bromine before planting onion, garden beet, celery and potato. Methyl bromide must be applied under a plastic cover according to the manufacturer's directions.

Only those who have a permit may apply methyl bromide. A permit may be obtained from Pesticides Control Section, Ministry of the Environment, 135 St. Clair Avenue West, Toronto, Ontario M4V 1P5, **telephone (416) 323-4321**

SLUGS

Metaldehyde is specific for slug control. Most other chemicals have little effect on them. Slug baits, dusts, and sprays containing metaldehyde are registered for use in Canada, but in Ontario the slug bait appears to be the only one widely distributed.

WHITE GRUBS

To avoid injury by white grubs, do not plant vegetables on land that has been in grass sod for two or more years.

WIREWORMS

Wireworms are more likely to be a problem for the first two years following sod. There are two control programs:

a. **Seed Treatment:** For large-seeded vegetables (beans, etc.) use a lindane seed treatment.

b. **Broadcast or band soil treatment:** This treatment is necessary for potatoes. Use one of the following:

1. carbofuran
   Furadan 10 G 32.5 kg/ha (band treatment only)
2. fonofos
   Dyfonate 10 G 55 kg/ha

Immediately after application to the soil surface cultivate to a depth of 10 to 15 cm, or drill directly into the soil at planting time (consult the label).

CUTWORMS

Several species of cutworms attack vegetables. The dark-sided, redbacked, black and glassy cutworms appear early in the growing season. Depending on soil and climatic conditions, these species will attack the plants below or at the soil surface, or will feed on the foliage. Late-season damage is caused primarily by the variegated cutworm which is a foliage feeder.

Effective cutworm control is dependent on proper timing of insecticide applications under favourable soil and climatic conditions. The insecticides recommended for use are short-residual, and breakdown quickly in sunlight. Also, most species of cutworms go into the soil during the day and come out to feed at night. Thus, insecticide applications should be made in late afternoon or early evening when temperatures are lower and just prior to the time the insects come up to feed. The insecticides are also more effective on moist soil as compared to dry soil.

Note: **The insecticides recommended are not registered on all crops. Consult the label to determine registration on a specific crop, the preferred methods and rates of application, and the required interval between application and harvest, or request advice from your nearest Pest Management Specialist or Horticultural Crop Advisor.**

The following control programs can be used:

A. **Early-Season Species of Cutworms:**

1. *Preplanting cover-crop treatment:* Five days before plowing under the rye or wheat cover crop, when it is 10 to 15 cm high, apply chlorpyrifos once in 200-400 L of water per hectare. Applications should also be made to fencerows and to a 15-m strip of any nearby cover crop.
2. *Preplanting soil treatment:* Apply chlorpyrifos once in 200-400 L of water per hectare as a broadcast soil-surface application. **Do not incorporate on muck soils.**

NOTE: Where there has been a history of cutworm damage, 1 and 2 are the preferred methods of treatment. Preplanting treatments will not be phytotoxic to vegetable crops.

3. *Postplanting treatment:* When cutworm damage first becomes apparent apply either:
   (a) chlorpyrifos
   or
   (b) permethrin. Use higher rates of permethrin on dry and muck soils and when cutworms are large (2.5-4 cm long).
   or
   (c) cypermethrin
   Use sufficient water for good coverage (200-500 L/ha). DO NOT DISTURB the soil for at least 5 days after treatment.
   NOTE
   (1) Chlorpyrifos, permethrin and cypermethrin are effective **only** on surface-feeding stages of cutworms.
   (2) Chlorpyrifos, permethrin and cypermethrin are registered **only** for use on seedings (up to 5-leaf stage) and/or transplants.
   (3) Chlorpyrifos may be phytotoxic to some varieties of plants under stress conditions, i.e. hot, dry weather or cool, excessively wet weather.

B. **Late-Season Species of Cutworms:**

When cutworm damage first appears, apply carbaryl, [1]methomyl or permethrin in sufficient water for good coverage of foliage. Spray penetration of the foliage canopy is essential for good cutworm control. Best control will be obtained when cutworm larvae are small.

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[1]*Minimum period before reentry is 24 hours.*

DEER AND RABBIT CONTROL

Both deer and rabbits can be a serious problem in vegetable plantings particularly in areas where woodlots or other brush surround vegetable fields. Deer will often root for carrots in harvested fields.

Hinder is registered as both a deer and rabbit repellent. It can be applied using normal field spraying equipment. The rate to use is dependent on the severity of the problem. Hinder, at 2 to 4 litres per 100 litres should be applied at a volume of 450 to 950 litres of water per hectare. This results in an actual application range of 9 to 39 litres of Hinder product per hectare.

Hinder acts as a scent repellent. It is, therefore, important that the boundary margins of the affected fields, particularly areas where the deer or rabbits are entering, be thoroughly covered with spray solution.

CHEMICAL SEED TREATMENT

All vegetable seed should be treated with a fungicide to help prevent seed decay and damping-off.

To control black rot in cabbage, cauliflower, Brussels sprouts, broccoli and rutabaga treat the seed with streptomycin. Check the label for method of treating the seed and rates, etc.

To control seedcorn maggot, treat seeds of bean, corn, pea, cucumber, melon, squash and other large-seeded crops with diazinon insecticide and with lindane insecticide for wireworm control. **To avoid insecticide injury to the seed, apply insecticides only in combination with a fungicide.** The combination seed treatment containing captan or thiram and both insecticides should be used each season because not all wireworms are killed and seed maggots are usually present.

Treat seed not longer than three months before planting, with a combination lindane-diazinon-captan or lindane-diazinon-thiram.

Commercial seed dressings containing these chemicals are available. Check labels for registered crops and rates of application.

Use a combination lindane-diazinon seed treatment on seed already treated by the seed company with a fungicide or a fungicide plus malathion. Although commercial seed-treating equipment gives the best coverage, seed may be treated on the farm. Mix the required amount of chemicals in 0.8 L of water and thoroughly mix it with one hectolitre of seed. Use a cement mixer or shovel. Spread out the treated seed to dry before bagging.

Alternatively, buy seed treated with a fungicide and the two recommended insecticides. Purchased seed may have been treated to control storage insects. Such treatment does *not* control seed maggots and wireworms in the field. *Consult the tag or label on the package to see what was used to treat the seed.*

WARNING

The concentrations of pesticides in seed treatments are high and thus the products are quite toxic. Wear rubber gloves, full protective clothing and a respirator when treating seed. Avoid skin contact and breathing the fumes. Do not handle treated seed with bare hands. Dispose of surplus treated seed by burying it under 50 cm of soil in an area away from water supplies.

HOT-WATER SEED TREATMENT

Buy hot-water treated seed or treat seed as follows:
Place seed in a cheesecloth bag of ample size; the bag should not be more than half full. Wet seed and bag with warm water. Soak cabbage, broccoli, Brussels sprouts, tomato, pepper and eggplant seed for 25 minutes in water maintained at 50° C. Then spread seed out to dry. Treat cauliflower, kohlrabi, kale, and summer turnip seed as above but for 15 minutes. Treat celery seed at 48° C for 30 minutes. *Tomato seed can be treated at 54°C for 25 minutes but must be planted within a few days. Use an accurate thermometer. Stir the water and bags of seed continually to secure rapid penetration of heat to maintain uniform temperature in the seed lot. **(Consult OMAF Factsheet, Vegetable Seed Treatments, Agdex 250/23.)**

**Tomato seed can be treated by soaking dry seed in 3 parts of 0.6M hydrochloric acid (i.e. mix 1 part acid with 19 parts of distilled water) for 1 hour. Drain the acid, thoroughly rinse in distilled water and dry. A 0.1M hydrochloric acid is available from scientific supply companies and can also be used without the need for rinsing afterwards.*

DAMPING-OFF OF SEEDLINGS

Affected seedings rot at ground level and topple over. The damping-off fungus may cause seed decay also.

Steam or fumigate used flats and soil for growing seedlings **(consult OMAF Publication 365, Greenhouse Vegetable Production Recommendations).** Treat seeds with a protectant fungicide (also see Chemical Seed Treatment). Bench tops or other surfaces used to accommodate seedling flats should be sterilized with steam, formaldehyde or other effective disinfectant; alternatively, cover bench tops with clean plastic sheeting.

Water seedlings only when necessary and preferably before noon. Provide good ventilation and keep humidity low. If damping-off appears, water flats at rate of 5 L/m², 2 or 3 times, at 4-day intervals with oxine benzoate, ferbam or thiram. Follow manufacturer's directions regarding concentrations.

Where steam is used to treat soil, maintain a temperature not less than 82° C for 20 minutes throughout the soil. Avoid prolonged steaming.

Carefully follow manufacturer's directions for use of soil fumigants. *Only those who have a permit may apply methyl bromide.* A permit may be obtained from Pesticides Control Section, Ministry of the Environment, 135 St. Clair Avenue West, Toronto M4V 1P5, **Telephone (416) 323-4321.**

In time, treated soils become recontaminated by damping-off fungi. This can be delayed to a great advantage of flats of pepper and Spanish onion seedlings by treating the steamed soil with thiram 75% WP, 5 grams to a flat of soil, or 800 g/100 m² of bed. Thiram must be mixed thoroughly with the soil to a depth of 8 cm.

Disinfect used flats with steam; or immerse moistened flats in a solution of 5 L 37% formaldehyde in 125 L water, then set flats aside until the smell of formaldehyde disappears.

ASPARAGUS

CULTIVARS
(Revised for 1990)

Jersey Centennial Jersey Giant

GROWING SEEDLINGS

Soak seed in water about 32°C for 3 to 4 days. Dry and sow immediately in early spring in fertile, well-prepared soil. Plant seed 2.5 to 4 cm deep and 8 to 10 cm apart in rows 45 to 60 cm apart. One kilogram of good seed should provide enough crowns to plant one hectare. Plan to grow more plants than is needed to allow for selection of strong plants. Date of seeding is the last two weeks of May. Sow 11 kg of seed per hectare (approximately 250,000 crowns per hectare). Keep weeds and grasses controlled at all times.

FIELD SELECTION AND PREPARATION

Asparagus is a long-term vegetable crop which should produce viable yields for fifteen or more years. Therefore, thorough planning is essential for success. Field selection and preparation are key to good long-term production. Plant only into well-drained sandy or sandy loam soil free of perennial weeds and grasses. Eradication of perennial weeds and supplemental drainage improvement must be completed before the year of transplanting.

Soil testing is highly recommended to determine fertility levels and pH before transplanting.

Ideal soil pH should range between 6.0 and 6.8.

If possible, seed a green-manure crop the year before transplanting to increase soil organic matter. Livestock manure can also be used.

TRANSPLANTING AND SPACING

In early spring, dig the one-year plants, discard the weak or small crowns (less than 20 grams). Up to one-half the total crowns may be discarded. Plant the others in furrows so that the tops of the crowns are 15 cm deep. Space the plants 22 to 30 cm apart in rows 1.2 to 1.5 m apart. Spread out the roots and cover with not more than 5 cm of well-firmed soil. Fill in furrows gradually by cultivating as plants grow. Control weeds to retain high plant populations and vigorous growth.

TILLAGE AND FERN DISPOSAL

It is best to retain asparagus fern all winter in order to trap the snow and thereby protect the crowns from low-temperature winter injury. The fern can be cut up with a rotary or flail-type mower before minimum and light disking in early spring. The fern contributes organic matter to the soil. Use minimum cultivation for fern disposal and weed control. Excessive and deep tillage can injure crowns, which can increase Fusarium infection and reduce yields. Use zero tillage where suitable.

HARVEST OF SPEARS

Most asparagus plantings are vigorous enough so that they can be harvested for about 10 to 14 days in the spring of the third year after field setting (**i.e. field set spring 1990, first limited harvest spring 1992**). If asparagus vigour has been reduced by weed competition, insects or disease, or any other stress factor, harvest should be delayed to the fourth year after field setting. A 4-week harvest can then be undertaken.

An established asparagus planting is usually harvested for approximately 6 weeks. Harvesting should be terminated sooner if the emerging spears are too thin to meet the grade standards.

FERTILIZER

SOIL TESTS are required to determine phosphate and potash requirements (**see pages 26 and 27**). Take the soil sample at the depth of planting.

NITROGEN — For asparagus seeded in a NURSERY, apply up to 75 kg N/ha. For NEW PLANTINGS of crowns and ESTABLISHED plantings apply up to 110 kg N/ha.

APPLICATION — For the NURSERY, broadcast the N with all of the phosphate and potash required and work in before seeding. An additional 50 kg N/ha may be applied as a side-dress application in August or early September if rainfall is excessive. For NEW PLANTINGS, broadcast all of the N with the potash preplanting. All of the phosphate should be banded below the crowns at planting. If a green-manure crop is planted in the previous year, apply 30 to 40 kg N/ha and as much phosphate and potash as that crop requires, based on soil tests, before or at seeding. If manure is applied or legume sod is plowed down, reduce the nitrogen application (**see tables on pages 16 and 18**). For ESTABLISHED plantings, apply one-half of the N with all of the phosphate and potash required, broadcast, in early spring. Broadcast the remainder of the N immediately after harvest.

DISEASE CONTROL

RUST — All commercial cultivars are susceptible to rust. Disease control is achieved only with thorough spray coverage on a regular preventative schedule. This spray must protect new foliage as it grows, before rust spores can land on it and germinate. Start spraying new, non-harvested plantings as soon as growth is about 30 cm high (late May). For harvested plantings, begin spraying as soon as fern growth commences after harvest is complete. A 7- to 10-day schedule is essential until at least late August to protect the fern growth. A high-boy sprayer with drop arms having three nozzles per row is needed for full spray coverage.

Spray with one of:

1. zineb
   Zineb 80 WP 2.5-2.75 kg
2. metiram
   Polyram 80 DF 2.25-3.25 kg

Use high rate on full grown fern.

BOTRYTIS — This disease attacks plants which are damaged from rust or beetle feeding. Under wet weather conditions it can cause serious plant injury. A regular spray program for rust, and good control of beetles before serious feeding occurs, is the best control recommendation.

ASPARAGUS (Continued)

FUSARIUM DISEASES — Avoid replanting on land which previously grew asparagus. Otherwise, fumigate soil with Vorlex 0.6 L per 10 m² before planting. Consult manufacturer's directions. Follow all safety precautions.

In addition to soil fumigation, the following treatment may give additional protection against Fusarium and other soil-borne organisms, and furthermore, on new asparagus land, crowns may also be treated as follows:

Mix Benlate 50% WP 2 grams/litre of water. Dip 3000 crowns in 1000 L solution for 15 to 20 minutes before planting.

Use treated seed.

Use vigorous one-year-old crowns when transplanting.

Care should be taken to avoid stresses, because these make asparagus more susceptible to Fusarium diseases, and reduce the longevity of the planting.

Stresses which promote these diseases are: overpicking, or picking before crowns are well established; insect and other disease damage; weed competition; excessively deep tillage; poor soil drainage; soil compaction; acidic soil pH; drought; injury from misapplication of pesticides, fertilizers, manure; and low fertility.

Consult OMAF Factsheet, Diseases of Asparagus, Agdex 254/635.

INSECT CONTROL

ASPARAGUS BEETLES — Because there are several generations of these beetles, they are a constant threat throughout the season. Begin spraying when adult beetles are observed before egg laying in the spring.

Spray:

1. methoxychlor
   (i) Methoxychlor 50% WP 3.25 kg (3 days)
   (ii) Methoxychlor 25 EC 3.8-8.5 L (3 days)
2. malathion
   (i) Malathion 500 EC 2.75 L (1 day)
   (ii) Malathion 25% WP 4.5 kg (1 day)
3. rotenone
   Rotenone 5% WP 6 kg plus spreader (1 day)
4. carbaryl*
   Sevin XLR Plus 2.5-6.4 L (2 days)

Use only during harvest; do not use during fern growth period.
**See note on Bee Warning*

5. cypermethrin
   Cymbush 250 EC 140 mL (1 day)

APHIDS — Sprays for aphids should be applied at 3-to-4- week intervals as needed until defoliation in October. For immature asparagus, begin application mid-May. For mature asparagus, begin application July 1, after the crop has been harvested.

Spray with one of:

1. pirimicarb
   Pirimor 50 WP 1 kg in 675 L of water/ha
2. dimethoate
   (i) Cygon 480 EC 2.3 L in 675 L of water/ha
   (ii) Sys-Tem 480 EC 2.3 L in 675 L of water/ha
3. disulfoton
   Di-Syston 720 LC 1.5 L
   (Maximum of 2 applications per year)
4. oxydemeton-methyl
   Metasystox-R 240 SC 1.75-2.25 L
   (Maximum of 3 applications per year)

CUTWORMS — Apply when cutworm damage first becomes apparent.

1. sevin
   Sevin XLR Plus 2.5-6.4 L (2 days)
2. permethrin
   Ambush 500 EC 140 mL (2 days)

Also see page 30.

PIGWEED CASEBEARER — Control pigweed compietely in the planting and in headlands because if casebearers develop on pigweed, they may contaminate the crop in May and early June the following year.

Consult OMAF Factsheet, Insect Pests of Asparagus, Agdex 254/625.

BEE WARNING

Bees are attracted to asparagus bloom. Where spraying is being done, bee poisoning may result. Dimethoate is toxic to bees and should not be used during the bloom period. Carbaryl is especially toxic to bees and should not be used during the fern-growth period. With other insecticides, losses to bees can be reduced if sprays are applied in early morning or late evening when the bees are not foraging. Advise local beekeepers of spraying activity. Your local Agricultural Representative has a list of beekeepers in your area.

STORAGE OF SPEARS

Freshly harvested asparagus is very perishable and loses quality rapidly. Collect the spears as soon as possible, protect them from the sun, and move them to cold storage, the processor or a market as soon as possible. If short-term storage is necessary, store under high humidity at 1 to 2°C. **Consult OMAF Factsheet, Maintaining Asparagus Quality from Producer to Consumer, Agdex 254/57.**

BEAN (SNAP AND LIMA)

CULTIVARS
(Revised for 1990)

GREEN BUSH	YELLOW BUSH
Processing	*Processing*
Win	Eureka
Early Gallatin	Goldrush
Bush Blue Lake 47	
Strike	
Eagle	*Fresh Market*
	Cherokee
Fresh Market	Kinghorn
Peak	
Improved Tendergreen	LIMA
Contender	Early Thorogreen
Provider	Fordhook 242
Strike	Mendoza Bush

SEEDING AND SPACING

Snap Beans (Green and Yellow)

Sow as shallow as soil moisture permits, usually 2.5 to 4 cm deep. The following row spacings and seed rates are suggested for optimum yields depending on the harvest method or on the type of mechanical harvester used.

Seeding rates must be adjusted according to cultivar and germination percentage. Snap beans grown for processing can only be grown in narrow rows (less than 80 cm) when a Multi-D harvester is used. With narrow rows a complete chemical weed-control program is necessary which will provide consistent control of weeds.

Optimum germination temperature is 16 to 29°C. At low soil temperatures, seed decay is more serious.

SPACING AND SEEDING RATES

Row Spacing cm	Plants per metre of row	Seeding Rate per hectare	Harvest Method
90 to 95	20 to 26	80 kg	Mechanical (all kinds) and hand pick
45, 50 and 60	17 to 22	100 kg	Mechanical (Multi-D) and hand pick
22 to 25	10	110 kg	Mechanical (Multi-D)
15 to 18	—	165 kg	Mechanical (Multi-D)

Lima Beans

Use 55 to 65 kg of seed per hectare. Seed approximately 4 to 5 cm deep, depending on soil moisture. Rows are spaced 60 to 70 cm.

FERTILIZER

SOIL TESTS are required to determine phosphate and potash requirements **(see tables on pages 26 and 27).**

NITROGEN — 15 kg N/ha is recommended at seeding where phosphate and potash are required. If no phosphate and potash are required, the nitrogen may be omitted. Side-dressing of nitrogen is only recommended following heavy rains if foliage indicates nitrogen deficiency; apply approximately 60-80 kg of additional actual nitrogen per hectare.

APPLICATION — Fertilizer may be broadcast before seeding and worked in or banded 5 cm below and 5 cm to the side of the seed. High rates of banded potassium can reduce; yield; therefore, banded potassium should not exceed 60 kg k_2O/ha.

MICRONUTRIENTS — MANGANESE deficiency may be a problem on beans on some soils with pH values above 6.5. Correct the deficiency as soon as detected by spraying the foliage with 1.0 kg manganese/ha from manganese sulfate, or from manganese in chelated form, in 300 L of water. Use a "spreader sticker" in the spray. If the deficiency is severe, a second spray may be beneficial. Soil application is not recommended for manganese because of the large amounts required.

BORON — Beans are very sensitive to boron toxicity and should not be grown the year after boron has been applied for other crops.

ZINC deficiency has been reported on beans in Michigan, but appears to be very rare in Ontario.

DISEASE CONTROL

1. Plant seed that is free from organisms causing **bacterial blight, anthracnose, common mosaic and yellow mosaic.** The best source of snap bean seed free from anthracnose and blight is the western United States.
2. Practise a crop rotation of at least 3 years to help control Fusarium and other soil-borne root rots, bacterial blight, anthracnose, and Sclerotinia white mold. Where disease is a problem, it may be necessary to practise a 4- to 5-year rotation. Include in the rotation crops other than field beans, snap beans, pole beans, kidney beans, lima beans, soybeans and peas.
3. Maintain vigorous plant growth. Fertilize adequately. Avoid poorly drained or compacted soils.
4. Do not cultivate or harvest when plants are wet.
5. Plow under crop residues in the fall to hasten destruction of disease organisms. Do not spread bean refuse, or manure containing bean refuse, on land intended for beans during the next 3 years.

SCLEROTINIA WHITE MOLD — Plant fields in exposed areas where air circulation is maximum. For snap beans grown in fields where white mold has been a problem in recent years, spray at first bloom with one of:

1. benomyl
   Benlate 50% WP 2.25 kg (14 days)
2. dichloran
   Botran 75 W 3.25 kg (2 days)

BEAN (SNAP AND LIMA) Continued

3. iprodione
   Rovral WP 1.5 kg (15 days)
   (spray at 50% bloom)

Spray must penetrate the crop canopy and contact blossom petals. Use of drop nozzles and overhead nozzles, and high pressure (up to 2000 kPa) give best results. Applications made after bloom are not effective. If wet weather persists, a second spray will be beneficial.

COMMON MOSAIC AND YELLOW MOSAIC — Common mosaic virus is seed-borne and is also spread by aphids from infected beans. Some of the recommended snap beans are resistant to this virus. Check with your seed supplier. Avoid planting beans next to forage legumes or sweet clover from which aphids may spread yellow mosaic

BRONZING — Bronzing is a physiological disorder caused by high levels of atmospheric ozone associated with air pollution. It occurs following the initiation of flowering and after the older leaves become fully mature. A bronze-colored stipple develops on the pods and the upper surface of the leaves. Pod and seed set are usually reduced and the plants age prematurely. Dry beans and limas appear more sensitive than snap beans, and cultivars within these types differ in susceptibility.

INSECT CONTROL

SEED MAGGOTS, WIREWORMS AND SEED DECAY — Treat seed with diazinon, lindane, and a fungicide. (See Chemical Seed Treatment, page 31.)

LEAFHOPPERS, MEXICAN BEAN BEETLE AND GREEN CLOVERWORM — Spray with one of:

1. carbaryl
   Sevin XLR Plus 1.25-2.5L (5 days)
2. [2]azinphos-methyl
   (i) [2]Guthion 240 SC 2.25 L (3 days)
   (ii) [2]Guthion 50 W 1.1 kg (3 days)
   (iii) [2]APM 50 WP 1.1 kg (3 days)
3. endosulfan
   (i) Thiodan 4-EC 2.1 L (2 days)
   (ii) Thiodan 400 EC 1.5 L (2 days)
   (iii) Endosulfan 50 WP 1.1 kg (2 days)
4. dimethoate
   (i) Cygon 480-E 0.75 L (7 days)
   (ii) Sys-Tem 480 EC 550-1000 mL (7 days)
   (iii) Cygon 4E 0.85-1.25 L (7 days)
5. malathion
   (i) Malathion 25% WP 4.5 kg (3 days)
   (ii) Malathion 500 EC 2.75 L (3 days)

Note: 4 and 5 are not effective on green cloverworm.

CORN BORER — Corn borer has been a problem on snap beans in some areas in the past few years. Control requires a number of repeated applications of insecticides timed carefully. Consult your processor and Horticultural Crop Advisor or Pest Management Advisor. The following insecticides are registered for control:

1. permethrin
   Ambush 500 EC 200 mL (7 days)
2. [1]methomyl
   [1]Lannate 2.25 L (7 days)
3. [2]azinphos-methyl
   [2]Guthion 240 SC 2.25 L (3 days)
4. carbaryl
   Sevin XLR Plus 5.25 L (5 days)

APHIDS (lima beans only) — Spray with one of:

1. dimethoate
   Cygon 480-E 0.75 L (7 days)
2. malathion
   (i) Malathion 25% WP 3.25-4.5 kg (1 day)
   (ii) Malathion 500 EC 2.75 L (1 day)

TARNISHED PLANT BUG — Effectively controlled with dimethoate when sprayed for aphids or leafhoppers.

[1]*Minimum period before reentry is 24 hours.*
[2]*Minimum period before reentry is 48 hours.*

Do Not Feed Bean Refuse to Livestock or Poultry if the Crop was Treated with endosulfan, dimethoate or benomyl.

BEET

CULTIVARS
(Revised for 1990)

MINERAL SOIL	MUCK SOIL
Gladiator	Avenger (2)
King Red	Big Red (1,2)
Ruby Queen	Detroit Rubidus (1)
	Pacemaker III (1,2)
BUNCHING	Red Ace (1)
Avenger	Ruby Queen (1)
Crosby Egyptian	Supra (1,2)
Detroit Dark Red	
Greentop	
Little Egypt	
Sangria	
PROCESSING	(1) Suitable for fresh market.
As recommended by processors.	(2) Suitable for processing.

SEED TREATMENT

Treat seed before planting with thiram seed protectant. Follow manufacturer's directions.

TRANSPLANTING

For very early beets, sow seed in the greenhouse 6 to 7 weeks before transplanting to the field in mid-April. In the field, space the plants 8 cm apart in rows 30 to 40 cm apart.

FIELD SEEDING AND SPACING

For a continuous supply of beets for bunching, sow seed at 2-week intervals, from early April to the end of July. For storage and processing, sow about 10 weeks before late-fall harvesting. Seed will not germinate at temperatures lower than 4°C. Optimum germination temperature is from 10 to 29°C. Sow seed 12 to 20 mm deep. About 7 kg of seed will plant one hectare.

Thin plants 5 to 8 cm apart. No thinning is required on muck soils when seeders are adjusted to ensure a stand of 32 to 40 plants per metre of row. Rows 30 to 40 cm apart, depending on foliage size of cultivar.

FERTILIZER

SOIL TESTS are required to determine phosphate and potash requirements **(see tables on pages 26 and 27).**

NITROGEN — On MINERAL SOILS apply up to 110 kg N/ha. On MUCK SOILS apply up to 40 kg N/ha. If manure is applied or legume sod is plowed down, reduce the nitrogen application **(see tables on pages 16 and 18).**

APPLICATION — On MINERAL SOILS broadcast 65 kg N/ha and all of the phosphate and potash required before planting and work in. The remainder of the N should be side-dressed.

MICRONUTRIENTS — BORON deficiency shows up as a breakdown and corky, dark discoloration of internal tissues **(see page 24).**

MANGANESE — Deficient plants show marked yellowing between the leaf veins; the veins themselves remain green. To correct a deficiency, spray with manganese sulfate **(see page 24).**

DISEASE CONTROL

DAMPING-OFF AND SEEDLING DISEASES — **(see Seed Treatment, page 31).**

NEMATODES — To avoid damage from sugar-beet cyst nematode, do not plant beets following rhubarb, spinach or beets **(see Crop Rotation and Nematodes, pages 27 and 29).**

INTERNAL BREAKDOWN (BORON DEFICIENCY) — Most likely to occur on alkaline soils after prolonged hot, dry periods **(see Boron, page 24).**

INSECT CONTROL

LEAFMINER — Usually required only for bunching beets. When mines first appear, spray with one of:

1. dimethoate
   Cygon 480-EC 0.7 L (3 days)
2. [3]parathion
   (i) [3]Parathion 15% WP 2.25 kg (15 days)
   (ii) [3]Parathion 960 E 350 mL (15 days)
3. malathion
   (i) Malathion 25% WP 4.5 kg (7 days)
   (ii) Malathion 500 EC 1.75 L (7 days)

APHIDS — If a problem, spray with one of:

1. dimethoate
   (i) Cygon 480-EC 0.75 L (3 days)
   (ii) Sys-Tem 480 EC 700 mL (3 days)
2. [3]parathion
   (i) [3]Parathion 15% WP 2.25 kg (15 days)
   (ii) [3]Parathion 960 E 350 mL (15 days)
3. diazinon
   (i) Diazinon 50% WP 1.1 kg (14 days)
   (ii) Diazinon 500 EC 1.1 L (14 days)
   (iii) Basudin 500 EC 1.1 L (14 days)

[3]*Minimum period before reentry is 7 days.*

QUALITY AND STORAGE

Heavy rains following a hot, dry period, or extended periods of high temperature, will cause poor colour. Rains in the late summer or early fall, when cooler temperatures occur, may increase the intensity of colour. In general, cool temperatures produce the best flesh colour.

Mature topped beets may be stored for up to 5 to 6 months at 0°C and 90 to 95% relative humidity.

CABBAGE, CAULIFLOWER, BROCCOLI, BRUSSELS SPROUTS

COLE CROP CULTIVARS
(Revised for 1990)

CABBAGE

Early	*Mid-season*
Early Greenball[1]	Green Express YR
Early Marvel[1]	Shamrock
Tucana[1]	Superette
Luna (Polar Green)	Sanibel YR
Green Express YR	Market Prize
Headstart	Prime Time
Sun-up	Survivor (Questo)
Charmant	

Late (storage type)	*Savoy*
Stonar YR (trial)	Savoy King
Safekeeper II YT	Chieftain
Hinova YR	Ice Prince
Brutus	Ice Queen
Lennox	
Atria YR (trial)	
Multiton YR (trial)	*Red*
Structon YR (trial)	Ruby Ball
April Green	Red Acre YT
Bartolo	Ruby Perfection
Zerlina (very late)	

CAULIFLOWER[3]

Early Crop (mineral soil)	*Late Crop (mineral soil)*
Snow Crown	Snow Crown
Polar Express	Andes
	White Fox
	Taipan
	White Summer
Mid-season (mineral soil)	White Rock
Snow Crown	White Top
Taipan	White Sails
Early Crop (muck soil)	*Late Crop (muck soil)*
Snow Crown	Snow Crown
	White Summer
	Hormade
	Andes

BROCCOLI *(mineral soil)*	**BROCCOLI** *(muck soil)*
Baccus *(trial)*	Southern Comet
Packman *(trial)*	Top Star
Paragon	Futura
Emperior	Paragon
Premium Crop	Emperor
Cruiser	Premium Crop

BRUSSELS SPROUTS

Jade E	Silverstar YT[4]
Lunet[4]	Valiant[4] *(trial)*

[1] *For early areas only.*
[2] *Not recommended for long-term storage.*
[3] *Cauliflowers listed are for fresh market, to produce curds not more than 20 cm in diameter. For processing cultivars, growers should follow processors' requirements.*
[4] *Probably matures too late for zones other than A, B, and C* (see Figure 1, page 12).
*YT: Fusarium Yellows tolerant***
*YR: Fusarium Yellows resistant***
** *Based on seed company claims and field trial testing.*

Consult **OMAF Factsheet, Production and Handling of Broccoli, Agdex 252/20.**

SEED TREATMENT

Sow seeds that have been hot water-treated and dusted with thiram or captan seed protectant. Follow manufacturer's directions. Hot-water treatment (see page 31) is most important to help prevent black rot, blackleg and bacterial leaf spot.

To control black rot, seed may be treated with streptomycin as an alternative to hot-water treatment. Follow manufacturer's directions on the label.

SEEDING AND SPACING

About 300 to 350 grams of seed will provide enough transplants for 1 hectare at standard spacing.

CABBAGE (EARLY), BROCCOLI — Rows 60 to 75 cm apart. Plants 30 to 45 cm apart.

CABBAGE (LATE), CAULIFLOWER, AND BRUSSELS SPROUTS — Rows 75 to 90 cm apart. Plants 45 to 60 cm apart.

The newer compact hybrids may be grown at closer spacings than the older traditional cultivars.

With Brussels sprouts grown for a once-over harvesting and especially where smaller sprouts are required for freezing, uniformity of the sprouts up the stem can be improved by growing the plants on a closer square spacing, e.g. 60 x 60 cm, or even as close as 53 x 53 cm.

For broccoli crops anticipated to be harvested during the hot, humid weather or late August-early September, plant spacings should be increased to the wider end of the range recommended.

DIRECT FIELD SEEDING

Direct seeding in the field is practical for late summer and fall crops of cabbage, cauliflower, broccoli and Brussels sprouts. If precision seeders are used, it is false economy not to use graded seed. Some seeder units may be operated with seeds of well-defined sizes to give precise spacings on the ground. Extra care must be taken with soil preparation, and it may be necessary to irrigate before seeding to ensure good moisture conditions for germination. Depth of seeding should be 6 to 12 mm.

CABBAGE, CAULIFLOWER, BROCCOLI, BRUSSELS SPROUTS (Continued)

Direct seeding is particularly applicable where high plant populations are required. Seeding date should be 10 to 14 days after the normal date for seeding for a transplant crop of the same season of maturity. Even for the most favorable areas of Ontario, crops should probably not be direct seeded after about June 30.

FERTILIZER

SOIL TESTS are required to determine phosphate and potash requirements **(see tables on pages 26 and 27).**

NITROGEN — On MINERAL SOILS, broccoli, cauliflower and Brussels sprouts should receive 130 kg N/ha; and cabbage 170 kg N/ha. For MUCK SOILS, suggested maximum is 130 kg N/ha with 70 kg/ha preplant plus two side-dresses of 30 kg/ha each, while cabbage should receive an initial 100 kg/ha preplant. If manure is applied or legume sod is plowed down, reduce the N application **(see tables on pages 16 and 18).**

APPLICATION — Broadcast three-quarters of the N and all of the phosphate and potash required before planting, and work in. The remainder of the N should be side-dressed about 3 weeks after field setting. If rainfall is excessive, an additional 40 kg N/ha may be side-dressed on sandy soils. For MUCK SOILS, up to 70 kg N/ha should be applied before planting and the rest split into two equal side-dressings as needed.

STARTER SOLUTION — If no insecticide is being added to the planting water, use a starter solution high in N such as 20-20-20 at 1 kg/200 L and apply 0.2 to 0.3 L per plant. Under high-temperature conditions or in dry sandy soils, use only 1/2 kg of 20-20-20/200 L of water. This will reduce the risk of crop injury under these growing conditions.

MICRONUTRIENTS — BROWN HEART or HOLLOW STEM (BORON DEFICIENCY) - On soils known to be deficient in boron, apply 2.5 to 3.0 kg of boron/ha and disk in before planting. Foliar sprays of boron can be made during the growing season (see page 24). Boron deficiency has been shown to cause Hollow Stem in broccoli, but all Hollow Stem is not caused by boron deficiency.

WHIPTAIL (MOLYBDENUM DEFICIENCY) - Deficiency causes whiptail in cauliflower, broccoli, and Brussels sprouts. If molybdenum is deficient, apply sodium molybdate mixed with the fertilizer at rates supplying 0.6 to 0.8 kg of molybdenum/ha or apply 10 to 15 g of molybdenum per 100 L of water at 0.3 L per plant at transplanting. If deficiency symptoms appear in the field, spray immediately with 60 g of molybdenum dissolved in 300 L of water applied to one hectare.

SPECIAL PROBLEMS

CABBAGE SPLITTING

When the heads are well developed, they may split or burst if rain or a heavy irrigation follows a dry spell. Splitting results from rapid new growth due to the increased moisture. Splitting may be partially avoided by checking the plants' growth, (e.g., by deep cultivation to break some of the roots). Proper irrigation may prevent splitting by helping to maintain steady plant growth.

CABBAGE BOLTING

Premature seedstalk development may occur when plants are started too early and grown at too low temperatures early in the growing season. The earlier the seed is sown, the greater the bolting tendency. Bolting may also be caused by extreme changes in temperature, poor soil conditions, low nutrient levels, or other factors which cause checks to plant growth. Some cultivars, particularly early ones, are more susceptible to bolting than others.

CAULIFLOWER BUTTONING

Buttoning is the premature formation of a cauliflower curd, and because the curd forms very early in the plant's life, the leaves are not large enough to nourish the curd to a marketable size. Buttoning usually occurs shortly after planting in the field, when normal plants of the same age are growing vegetatively. Losses are usually most severe in the early-planted crop during cold, wet seasons, when vegetative growth is checked. Conditions which may cause buttoning include:

- a too rapid hardening-off treatment of young plants raised under protection
- insufficient hardening-off treatment of young plants before being planted in the field
- unbalanced soil fertility in the field (particularly low nitrogen)
- low soil moisture
- extreme and continued cold weather (e.g., 4 to 10°C for 10 days or more), especially in combination with excess moisture
- certain diseases, insects and trace-element deficiency, such as club root, root maggot and molybdenum deficiency (whiptail)

In short, conditions which reduce the vigour of the plant and retard vegetative growth appear to encourage buttoning. Some cultivars, particularly early ones, are more susceptible than others.

CAULIFLOWER BLANCHING

A perfect head of cauliflower is essentially pure white or pale cream. Heads exposed to sunlight develop an objectionable yellow pigment. While the head is small it is covered by the small inner leaves which curve over it, but as the head grows and enlarges, these leaves begin to lift, and some other means of covering is necessary to exclude sunlight. The usual method is to tie the outer leaves over the heads when the heads are 8 to 10 cm in diameter.

The heads tied at different times should be marked by different colours of twine or rubber bands to indicate probable maturity dates and thus facilitate harvesting. In hot weather, blanching may take only 3 to 4 days, but in cool weather, when growth is slow, 8 to 12 days or more may be required.

Some cultivars are better able than others to give natural curd protection by the inner wrapper leaves, without tieing. Generally speaking, cultivars originating in Europe, which appear in the recommended list in this publication, have better natural curd protection than the traditional North American cultivars.

CABBAGE, CAULIFLOWER, BROCCOLI, BRUSSELS SPROUTS (Continued)

BROCCOLI HARVESTING

The heads are cut with 15 to 20 cm of stem. Lateral shoots from the axils of the leaves develop into marketable heads soon after the terminal head is removed. These laterals produce a continuous crop for several weeks. However, some of the new hybrids produce very few laterals. Continuity of production with these cultivars may be obtained by successive plantings in the spring and summer. Heads should be cut when the clusters are green and compact. Open and yellow clusters are undesirable.

BRUSSELS SPROUTS HARVESTING

Harvesting should begin when the sprouts are firm and well formed. In picking, the leaf below the sprout is broken off and the sprout is removed. The upper sprouts continue to form and enlarge as the lower ones are harvested. In an early crop, the lower sprouts should be picked as soon as they mature; otherwise, they will open out, go soft and yellow, then rot.

For a once-over harvest, the plants should be topped, i.e. the growing point should be removed to prevent any further extension of growth and to encourage the maturity of the small sprouts at the top of the stem. Topping is normally done when the sprouts at the bottom of the stem are about 12 to 20 mm in diameter. In this way, a full stem of uniform marketable-sized sprouts will develop about 4 weeks later. Deleafing is necessary before a once-over harvest, but it should not precede harvesting by more than a day; otherwise, yield will be adversely affected.

DISEASE CONTROL

SEED DECAY, DAMPING-OFF, WIRESTEM, BLACK ROT, BLACKLEG, SOFT ROT, BACTERIAL LEAF SPOT OF CAULIFLOWER — Sow seed that has been hot-water treated and dusted with thiram or captan. Hot-water treatment (see page 31) is most important to help prevent black rot, blackleg, and bacterial leaf spot. For the control of black rot, as an alternative to hot-water treatment, treat the seed with streptomycin. Caution: streptomycin may be toxic to some cultivars. Follow manufacturer's directions.

Field seedbeds should not be located downhill from where cabbage and related crops have been grown, and where residues of these crops will be blown by wind or spilled from passing trucks, etc. To control disease-causing fungi and nematodes in seedbed soil, steam the soil or fumigate it with Vapam or Vorlex according to manufacturer's directions.

In the field, follow, where possible, a 3-year rotation with unrelated crops whether the crop is transplanted or direct seeded.

Avoid working among plants when they are wet. Do not irrigate with overhead sprinklers. In the fall or early spring, break up the crop refuse thoroughly and incorporate it into the soil.

YELLOWS — Use resistant cultivars (consult seed catalogue). If susceptible cultivars are grown, produce transplants in steamed or fumigated soil, and transplant to fields where yellows has not previously appeared.

CLUBROOT — This fungus causes swollen roots **(consult OMAF Factsheet, Diseases of Cruciferous Crops, Agdex 252/635)**. The resting spores in the fungus persist in soil at least 7 years. The organism is carried within and between fields in moving water. Therefore, avoid wet, poorly drained soils. Grow seedlings or transplants in soil free of disease. Beds may be fumigated with Vorlex or Vapam (consult manufacturer's label for directions). The most reliable control measure is liming with finely ground lime to a pH of 7.2 **(consult OMAF Factsheet, Soil Acidity and Liming, Agdex 534)**. Calcitic lime is preferable to dolomitic lime to attain a high level of soluble calcium (unless soils are low in magnesium). Where soil pH is above 7.0, Gypsum is a more soluble source of calcium.

Do not use hydrated lime on seedbeds. Fumigate seedbeds with Vorlex or Vapam if disease-free beds are not available (consult manufacturer's label directions).

Where Agral 90 is to be used for the control of clubroot, use 500 mL of product in 100 L of transplant water and apply this solution at a rate of 200 mL per plant. Do not tank mix this solution.

Some field control is possible by using quintozene (PCNB 75) in the transplant water at the rate of 1.5 kg in 200 L, applying at least 0.2 L per plant. This will be 3650 to 5600 L/ha. Provide good agitation. Do not use quintozene emulsion. No other method of applying quintozene is recommended.

DOWNY MILDEW — May appear in the seedbed or late in the growing season. Downy mildew spreads rapidly in cool, wet weather. Under these conditions preventive spraying is recommended, as the following fungicides will only prevent new infections and not eradicate established lesions:

1. zineb
   Zineb 80 WP 2.25-3.25 kg (7 days)
2. tribasic fixed copper*
   Kocide 54% WP 4.5 kg (1 day)

**fixed copper may be phytotoxic to cauliflower*

3. chlorothalanil
   Bravo 500 2.5-4.8 L (7 days)

BLACK LEAF SPOT (Alternaria) — May be damaging in warm, wet seasons. Spray with one of the materials listed for downy mildew. Maneb 80% WP 2.25 to 3.25 kg (7 days) may be used only on cabbage.

Note: It is important to control downy mildew and black leaf spot on cabbage intended for prolonged storage (more than 3 months). Spray with maneb or chlorothalanil 2 or 3 times during the latter part of the season.

NEMATODES — see page 29

CABBAGE, CAULIFLOWER, BROCCOLI, BRUSSELS SPROUTS (Continued)

INSECT CONTROL

ROOT MAGGOTS

Planting-Water Treatment

Use azinphos-methyl, Guthion 50 WP or APM 50 W, 1 kg in 1000 L of water. Apply 200 mL per plant in transplant water. Repeat in 2 to 3 weeks.

Treatment after Planting

Use one of:

1. [2]azinphos-methyl, [2]Guthion 50% WP or [2]APM 50 W 1 kg in 1000 L of water. Apply 200 mL per plant. Repeat in 2 to 3 weeks.
2. chlorpyrifos, Lorsban 4E 210 mL/130 L of water/1000 metres of row. Apply in a 10-cm band on each side of the plant 3 days after transplanting (not for Brussels sprouts). Note: this product has a 40 days-to-harvest interval.

Caution

— Do not use emulsifiable formulations in the planting water.
— Do not add fertilizer to planting water containing an insecticide unless recommended by the manufacturer or until experience has proven the mixture to be safe.

Direct-Seeded Crops

Use:

1. chlorpyrifos, Lorsban 4E 210 mL in at least 1000 L of water/ha per 1000 m of row (40 days-to-harvest). Apply 10 cm on each side of the plant 7-10 days after seeding or 3 days after transplanting (not for Brussels sprouts).

FLEA BEETLE — Spray with one of:

1. endosulfan
   (i) Thiodan 4 EC 2.0 L (7 days)
   (ii) Endosulfan 400 EC 1.5-2.0 L (7 days)
2. carbaryl
   Sevin XLR Plus 1.25-2.25 L (3 days cabbage and cauliflower, 5 days for broccoli and sprouts)
3. cypermethrin
   Ripcord 400 EC 90-125 mL (3 days)

CABBAGEWORM, CABBAGE LOOPER, DIAMONDBACK MOTH CATERPILLAR — Infestations of cabbageworm and diamondback moth caterpillar may begin early in the season, whereas cabbage loopers usually appear after mid-July. Because the recommended insecticides are less effective against large larvae, check carefully for young larvae, beginning soon after planting. Begin application of insecticides when young larvae are found and continue at 5- to 10-day intervals, or as necessary for adequate protection of the crop.

To limit the development of resistance, **insecticides from one of the following groups must be used alternately with one from another group.** Use insecticides in Group B during the fall, as they are more effective than the others under cool conditions.

Group A

1. *Bacillus thuringiensis*
   (i) Dipel 16000 I.U. per mg, 0.75-1.1 kg
   (ii) Thuricide 4000 I.U. per mg, 2.25-4.5 L

Use higher rates for looper control, heavy infestation or when foliage is dense (0 days).

Group B (Synthetic Pyrethroids)

1. permethrin
   (i) Ambush 500 EC 70-140 mL (3 days cabbage, cauliflower, Brussels sprouts; 7 days broccoli)
   (ii) Pounce 384 EC 90-175 mL (3 days cabbage, cauliflower, Brussels sprouts; 7 days broccoli)
2. fenvalerate
   Belmark 300 EC 150-325 mL (14 days cabbage, cauliflower, Brussels sprouts; do not use on broccoli)
3. deltamethrin
   Decis 2.5 EC 300-400 mL (3 days)
4. cypermethrin
   Ripcord 400 EC 90-125 mL (3 days)

Group C

1. [1]methomyl
   [1]Lannate L 2.25 L (1 day cabbage; 7 days cauliflower, broccoli, Brussels sprouts)
2. [2]methamidophos
   [2]Monitor 480 LC 1.1-2.25 L (7 days cabbage, cauliflower; 14 days broccoli, Brussels sprouts)

Group D

1. endosulfan
   (i) Thiodan 4 EC 2.0 L (7 days)
   (ii) Endosulfan 400 EC 1.5-2.0 L (7 days)

APHIDS — Good coverage (bottom of leaves) is essential for aphid control. Spray with one of:

1. dimethoate
   (i) Cygon 480 E 0.75-1.0 L (4 days cabbage, cauliflower, broccoli; 21 days Brussels sprouts)
   (ii) Dimethoate 40 EC 0.85-1.25 L (4 days cabbage, cauliflower, broccoli; 21 days Brussels sprouts)
2. [2]oxydemethon-methyl
   [2]Metasystox-R 240 SC 1.75-2.25 L (24 days cabbage, cauliflower, Brussels sprouts; 21 days broccoli). Use only once per season on broccoli.
3. [1]methomyl
   [1]Lannate L 2.25 L (1 day cabbage; 7 days cauliflower, broccoli, Brussels sprouts)
4. [2]methamidophos
   [2]Monitor 480 LC 1.1-2.25 L (7 days cabbage, cauliflower; 14 days broccoli, Brussels sprouts)

(Continued on Page 41)

PESTICIDE NAMES

Refer to this section for a cross-reference of brand names and common names of pesticides recommended in this publication. The centerfold section may be removed, if desired, for easier reference.

PESTICIDE NAMES

b - bactericide
i - insecticide
f - fungicide
m - miticide
n - nematicide
h - herbicide
g - growth regulator
( )Schedule (see list below)

Common Names		Brand Names	Common Names		Brand Names
aldicarb	(5) i	Temik	fonofos	(2,5) i	Dyfonate
anilizene	(3) f	Dyrene	formaldehyde	(3) i	Formalin
azinphos-methyl	(2,5) i	Guthion, APM	iprodione	(3) f	Rovral
Bacillus thuringiensis	(3) i	Thuricide, Dipel Bactospeine-A	lindane	(2) i	Lindane
			maleic hydrazide	(3) g	Royal MH 60 SG
benomyl	(3) f	Benlate	malathion	(3) im	Malathion
captan	(2) f	Orthocide, Captan	mancozeb	(3) f	Dithane M-45, Manate 200
carbaryl	(3) i	sevin	maneb	(3) f	Dithane M-22, Manzate D, Maneb
carbathiin + thiram	(3) f	Pro-Gro			
carbofuran	(2,5) i	Furadan	metalaxyl	(2) f	Ridomil, Subdue
chlorfenvinfos	(2,5) i	Birlane	metam-sodium	(3) bifnh	Vapam
chlorothalanil	(3) f	Bravo	methamidaphos	(5) i	Monitor
chlorpyrifos	(2,3) i	Lorsban	methidathion	(2) i	Supracide
cypermethrin	(2) i	Cymbush, Ripcord	methomyl	(2,5) i	Lannate
dazomet	(2) ifnh	Basamid	methoxychlor	(3) i	Marlate, Moxy, Methoxychlor
deltamethrin	(2) i	Decis	methyl bromide	(1) ifnh	MB-C2, Brom-o-gas
diazinon	(2,3) i	Basudin, Diazol	metiram	(3) f	Polyram
1,3-dichloropropene	(2) ifn	Telone II	methyl isothiocyanate/ 1,3 dichloropropene	(2) bifnh	Vorlex Plus
1,3-dichloropropene/methyl isothyiocyanate mixture	(2) bifnh	Vorlex Plus	naled	(2) i	Dibrom, Bromex
1,3-dichloropropene + chloropicrin	(2) ifn	Telone C-17	oxamyl	(5) i	Vydate
dichloran	(3) f	Botran	oxine benzoate	(3) f	No-Damp
dicofol	(2) m	Kelthane	oxydemeton-methyl	(2) im	Metasystox-R
dimethoate	(2,3) im	Cygon, Dimethoate 40, System	parathion	(5) im	Parathion
			permethrin	(3) i	Ambush, Pounce
dinoseb	(2) h	Dytop, Topper, Potato Top Killer	phorate	(2,5) i	Thimet, Cygard
			phosmet	(3) i	Imidan
diquat	(3) h	Reglone	piperonyl butoxide	i	piperonyl butoxide
disulfoton	(5) im	Di-Syston	pirimicarb	(2) i	Pirimor
endosulfan	(2) i	Thiodan, Endosulfan, Thionex	quintozene (PCNB)	(3) f	Quintozene, Terrachlor
			rotenone	(3,6) i	Rotenone
			streptomycin	(3)	Agri-Mycin 17
fenvalerate	(2) i	Belmark	thiophanate-methyl	(3,6) f	Easout
ferbam	(3) f	Ferbam	thiram	(3) f	Thiram
fixed copper	(2,3) bf	kocide, etc	zineb	(3) f	Thiogreen, Zineb

The numbers within the brackets ( ) identify the Schedules in which the BRAND NAME products listed in this section are classified under the Pesticides Act.

Explanation of Schedules:

Schedule 1 Restricted. Use permit only.
Schedule 2 Restricted to agriculturalists, licenced exterminators and registered custom sprayers.
Schedule 3 May be available for "Domestic" purposes if so registered.
Schedule 4 "Domestic" products only.
Schedule 5 Limited to application by an agriculturalist.
Schedule 6 Similar to schedule 4 but may be registered for agricultural/commercial use.

For further information on the regulatory aspects of the classification, please contact the Ministry of the Environment office nearest you **(see page 3).**

PESTICIDE NAMES (Continued)

b - bactericide
i - insecticide
f - fungicide
m - miticide
n - nematicide
h - herbicide
g - growth regulator
( )Schedule (see list below)

Brand Names		Common Names
Ambush, Pounce	(3) i	permethrin
APM, Guthion	(2,5) i	azinphos-methyl
Bactospeine-A, Dipel, Thuricide	(3) i	Bacillus thuringiensis
Basamid	(2) ifnh	dazomet
Basudin, Diazol	(2,3) i	diazinon
Belmark	(2) i	fenvalerate
Benlate, Benomyl	(3) f	benomyl
Benomyl, Benlate	(3) f	benomyl
Birlane	(2,5) i	chlorfenvinfos
Botran	(3) f	dichloran
Bravo	(3) f	chlorothalanil
Bromex, Dibrom	(2) i	naled
Captan, Orthocide	(2) f	captan
Cygon, Sys-tem, Dimethoate-40	(2,3) im	dimethoate
Cymbush	(2) i	cypermethrin
Decis	(2) i	deltamethrin
Diazol, Basudin	(2,3) i	diazinon
Dipel, Thuricide, Bactospeine-A	(3) i	Bacillus thuringiensis
Dibrom, Bromex	(2) i	naled
Dimethoate-40 Cygon, System	(2,3) im	dimethoate
Di-Syston	(5) im	disulfoton
Dithane M-22, Maneb Manzate D	(3) f	maneb
Dithane M-45, Manzate 200	(3) f	mancozeb
Dyfonate	(5,2) i	fonofos
Dyrene	(3) f	anilazine
Dytop, Topper, Potato Top Killer	(2) h	dinoseb
Easout	(3,6) f	thiophanate-methyl
Endosulfan, Thiodan, Thionex	(2) i	endosulfan
Ethion	(2) i	ethion
Ferbam	(3) f	ferbam
Formalin	(3) i	formaldehyde
Furadan	(5,2) i	carbofuran
Guthion, APM	(5,2) i	azinphos-methyl
Imidan	(3) i	phosmet
Kelthane	(2) m	dicofol
Kocide	(3) bf	fixed copper
Lannate L	(5,2) i	methomyl
Lindane	(2) i	lindane
Lorsban	(2,3) i	chlorpyrifos
Malathion	(3) im	malathion
Maneb, Dithane M22, Manzate D	(3) f	maneb
Manzate D, Maneb, Dithane M22	(3) f	maneb
Manzate 200, Dithane M45	(3) f	mancozeb
MB-C2	(1) ifnh	methyl bromide + 2% chloropicrin
Metasytox-R	(2) im	oxydemeton-methyl
Methoxychlor	(3) i	methoxychlor
Monitor	(5) i	methamidaphos
No-Damp	(3) f	oxine benzoate
Orthocide, Captan	(2) f	captan
Parathion	(5) im	parathion
Pirimor	(2) i	pirimicarb
Polyram	(3) f	metiram
Potato Top Killer, Topper,Dytop	(3) h	dinoseb
Pounce, Ambush	(3) i	permethrin
Pro-Gro	(3) f	carbathiin + thiram
Quintozene, Terrachlor	(3) f	quintozene (PCNB)
Reglone	(3) h	diquat
Ripcord	(2) i	cypermethrin
Ridomil	(2) f	metalaxyl
Rotenone	(3) i	rotenone
Rovral	(3) f	iprodione
Royal MH 60	(3) g	maleic hydrazide
Sevin	(3) i	carbaryl
Streptomycin 17	(3) b	streptomycin
Sys-tem, Cygon, Dimethoate 40	(2,3) im	dimethoate
Supracide	(2) i	methidathion
Telone II	(2) ifn	1,3 dichloropropene
Telone C-17	(2) n	1,3 dichloropropene + chloropicrin
Temik	(5) i	aldicarb
Terrachlor, Quintozene	(3) f	quintozene (PCNB)
Thimet	(2,5) i	phorate
Thiodan, Thionex, Endosulfan	(2) i	endosulfan
Thiogreen	(3) f	zineb
Thionex, Thiodan, Endosulfan	(2) i	endosulfan
Thiram	(3) f	thiram
Topper, Dytop, Potato Top Killer	(2) h	dinoseb
Thuricide, Dipel, Bactospeine-A	(3) i	Bacillus thuringiensis
Vapam	(3) bifnh	metam-sodium
Vorlex Plus	(2) bifnh	1,3-dichlorpropene/methyl isothiocyanate mixture
Vydate	(5) i	oxamyl
Zineb, Thiogreen	(3) f	zineb

CULTIVARS

SWEET CORN CULTIVARS

Days to Harvest	CHU	Cultivar	Type	Colour	Yield	Ease of Snapping	Appearance	Flavour
55	1600	Earlivee	Su	Y	99%	2.9	3.7	3.0
56	1700	Precocious	Se	Y	108%	2.9	4.6	3.8
59	1700	Spring Rush	Se	Y	85%	2.9	3.5	2.5
62	1700	Seneca Horizon	Su	Y	92%	4.4	3.9	3.6
	1800	Northern Super Sweet	SH2	Y	96%	4.1	3.3	4.2
63	1750	Maple Sweet	Se	Y	96%	3.2	3.3	4.2
65	1800	Tri-Sweet	Se	BC	90%	3.5	4.4	3.1
67	1800	Extra Early Super Sweet	SH2	Y	95%	3.7	3.4	3.3
68	1900	Burgundy Delight	Su	BC	112%	3.8	3.5	4.2
69	1850	Sweet Desire	SH2	Y	98%	4.0	3.9	3.9
70	1900	Spring Calico	Su	BC	110%	2.5	3.5	3.0
	1950	XPH 3008	Se	Y	96%	4.2	4.5	4.5
	1900	Top-Notch	SH2	BC	97%	3.4	4.0	3.8
75	1900	Norgold	Su	Y	108%	4.0	4.0	3.9
	1950	Bodacious	Se	Y	115%	4.0	4.5	3.8
77	2050	Sweeter Bi-Far	SH2	BC	103%	3.9	3.0	4.6
78		Yankee Belle	SH2	Y	102%	4.3	3.7	3.4
79	2000	Silverado	Se	W	100%	3.8	3.5	3.4
80		Calio Belle	Se	BC	110%	4.0	3.0	3.8
	2000	Candy Store	SH2	BC	112%	3.4	3.5	4.2
82	2050	Zenith	SH2	Y	105%	3.1	3.7	4.6
84	2050	Golden Jubilee	Su	Y	109%	3.0	3.1	3.0
	2050	Escalade	SH2	BC	104%	4.1	3.2	4.6
85	2050	Phenomenal	SH2	BC	120%	3.3	3.7	4.1
	2150	Flavour King	Se	Y	115%	3.7	3.0	4.0
86	2150	Flavourvee	Su	Y	110%	3.7	3.8	3.6
94	2250	Silver Queen	Su	W	100%	3.5	3.4	3.6

Days to Harvest — are the days listed in the seed catalogue. They do not accurately represent the actual days between planting and harvest.

CHU — Corn Heat Units are values that indicate the accumulation of temperature (heat) required to mature each sweet corn cultivar.

Type Su - Normal sweet corn
se - Sugar enhanced sweet corn
SH2 - Supersweet sweet corn

Colour Y - Yellow
BC - Bicolour
WH - White

Yield — The attempt is to base yields on trial plots with 100% plant stand. These 100% stands do not reflect seed vigour or seed viability in cold soils. The average variety yielded 100%.

Ratings are: 1 = poor, 5 = excellent for: - Ease of snapping
- Appearance (combination of tip full, tip cover and general husk appearance)
- Flavour

CABBAGE, CAULIFLOWER, BROCCOLI, BRUSSELS SPROUTS (Continued)

THRIPS — Dimethoate, as recommended for aphids, and all materials listed in Group B, as recommended for cabbageworm, etc., will give some control of thrips. Insecticides from Group B must be used alternately with dimethoate to limit development of resistance.

Lannate L @ 3.25 L (30 days) can be used on Brussels sprouts only, and only applied with ground equipment.

Consult OMAF Factsheet, Thrips On Onions and Cabbage, Agdex 250/612.

TARNISHED PLANT BUG — Dimethoate, as recommended for aphids, will help control tarnished plant bug in broccoli and cauliflower.

[1]*Minimum period before reentry is 24 hours.*
[2]*Minimum period before reentry is 48 hours.*

STORAGE

Late cabbage (Ballhead type) has a storage life of at least 3 to 4 months if held at 0°C with a relative humidity of 90% and good air circulation. Harvested heads should be trimmed at the base and dead or damaged leaves discarded. Avoid bruising during handling. Pallet bins are commonly used for holding cabbage in storage. Heads may also be stored in bulk but require very careful piling to a depth of not over 1.5 m together with ample aeration of the pile with forced air. Pallet bins should be stored outside and subjected to the sun and light to control fungi, which develop on the wood and stain the cabbage.

CARROT

The carrot is a cool-season vegetable which is best adapted to areas of long, cool growing periods, free from extremes of temperature and moisture. The optimum mean temperature is between 16°C and 21°C. High temperatures at the beginning of the growing season are injurious to the young plants. Continuous high temperatures in the latter stages of plant development may reduce yield, retard growth, and produce a strong-flavoured, coarse root. Temperatures below 16°C will retard plant growth. The carrot is not tolerant to drought and so requires steady and relatively large amounts of moisture for optimum growth. Good rainfall distribution or irrigation throughout the growing season is necessary to prevent a check in growth.

CULTIVARS
(Revised for 1990)

Processing	Packaging and Bunching	Use*
Camden	Candy Pak	1,2
Chantenay Strains	Canuck	1,2
Danvers 126	Caropak	1,2
Dess-Dan	Cellobunch	1,2
Processor II *(trial)*	Chancellor	1,2
Royal Danvers	Dominator	1
Spartan Bonus	Gold Pak 28 and 263	1
Spartan Bonus "80"	Orlando Gold	1,2
Tahoe *(trial)*	Paramount	1,2
	Pioneer	1
	Six-Pak and Six-Pak II	1,2
	Spartan Delight 80	1,2
	Spartan Fancy 80	1,2
	Spartan Premium 80	1,2

**Use: 1-Packaging, 2-Bunching*

Note 1: For cultivar susceptibility to rusty root and cavity spot, see Cultivar Descriptions.

CULTIVAR DESCRIPTIONS

Note: Cultivars are evaluated mostly on organic soils.

Camden — Danvers type with very good uniform internal colour, high yield potential, smooth exterior.

Candy Pak — Long and slender, good yield, good quality and appearance.

Canuck — Excellent length and shape, good colour and uniformity.

Caropak — Medium length, high yielding, good external colour.

Cellobunch — Very high yield potential, medium long, susceptible to green shoulders.

Chancellor — Long, good yielding, fairly uniform and smooth, tolerant to rusty root, blight and cavity spot, good colour, short-term storage.

Chantenay Strains — Medium length, broad shoulders tapering to blunt tips, strong tops.

Danvers 126 — More tapering and longer than most Chantenay types, fair to good internal colour.

Dess-Dan — Long Danvers type with very small core and very good internal and external colour.

Dominator — Long, good yield potential, partly Imperator type, suited for deep muck soils.

Gold Pak 28 and 263 — Imperator type with a narrow shoulder and relatively smooth skin, highly resistant to splitting, strong top, fair yields.

Orlando Gold — Long slender root, uniform shape and size, good exterior colour.

Paramount — Very early, medium long, high yielding, tolerant to cavity spot, blight and rusty root, fairly good colour.

Pioneer — High-yielding Nantes type, extremely uniform in size and type, medium long.

Processor II — Danvers type, high yield potential, good size, very good colour, smooth exterior and medium-size core.

Royal Danvers — High-yielding long Danvers type with good colour.

CARROT (Continued)

Six-Pak and Six-Pak II — Very long, very smooth and uniform, excellent colour, good yielding, good resistance to cavity spot and rusty root, tolerant to blight. Six-Pak II has excellent resistance to cavity spot.

Spartan Bonus — Long Danvers type, very uniform, smooth, high yielding, outstanding internal colour. Susceptible to seeders.

Spartan Bonus "80" — Similar to Spartan Bonus, except it is not susceptible to seeders.

Spartan Delight "80" — Long Imperator type, strong top, very good internal and external colour, resistant to rusty root.

Spartan Fancy "80" — Long Imperator type, strong top, very good internal and external colour, resistant to rusty root, tops susceptible to blight.

Spartan Premium "80" — Long Danvers type of good length, resistant to rusty root, tops susceptible to blight.

Tahoe — High-yielding Danvers type with very good internal colour, a small core and medium-short tops. Susceptible to cavity spot.

SOIL

Deep, loose, fertile soils that have good water-holding capacity are necessary for the development of long, straight roots. Well-drained sandy loam, peat, or muck are ideal for carrot production.

SEEDING AND SPACING

TIME — As early as soil and weather conditions permit in the spring up to July 1. Late carrots may "burn off" if they emerge during hot, dry weather.

RATE — Market: 2 to 4.5 kg/ha. Processing: 1 to 2 kg/ha.

DEPTH — 12 to 20 mm.

ROW SPACING — 40 to 60 cm depending on planting and harvesting machinery.

THINNING — Thin to 2.5 cm apart for packaging carrots, and to 4.0 cm for processing carrots. Thinning is usually not necessary on muck soils.

FERTILIZER

SOIL TESTS are required to determine phosphate and potash requirements. **(See table on pages 26 and 27.)**

NITROGEN — On MINERAL SOILS apply up to 110 kg N/ha. On MUCK SOILS apply up to 80 kg N/ha. If manure is applied or legume sod is plowed down reduce the nitrogen application. **(See tables on pages 16 and 18.)**

APPLICATION — On MINERAL SOILS it is suggested to apply 2/3 of the nitrogen before planting and the balance side-dressed when plants are 10 cm tall. On MUCK SOILS broadcast up to 80 kg N/ha before planting. This is a maximum. Adjust the rate downward if tops have been too vigorous in previous years.

MICRONUTRIENTS — BORON deficiency can cause necrosis in the growing tip or internal breakdown in carrot roots. Boron is recommended on new muck soils. Boron is applied mixed with the fertilizer at 2.6 kg boron/ha. Various sources of boron are available.

COPPER deficiency may occur on acid peat and muck soils. It results in poor orange colour development in the carrot roots. Apply 14-29 kg copper/ha on new muck. Subsequent applications may be made every 2 or 3 years at about 1/3 the rate recommended for new muck.

DISEASE CONTROL

SEED DECAY, DAMPING-OFF — Planting carrot seed treated with thiram has resulted in improved stands.

ASTER YELLOWS — See Leafhoppers (Insect Control section).

LEAF SPOTS, BLIGHT — Apply about 5 sprays, starting in late July, using one of:

1. maneb
   (i) Maneb 80% WP 3.25 kg (5 days)
   (ii) Dithane M22 3.25 kg (5 days)
2. mancozeb
   (i) Manzate 200 2.55 kg (7 days)
   (ii) Dithane M-45 2.25 kg (7 days)
3. zineb
   (i) Zineb 80% WP 3.25 kg (7 days)
   (ii) Thiogreen 80% WP 3.125 kg (7 days)
4. chlorothalanil
   Bravo 500 2.4-3.2 L (1 day)

An alternative weather-timed spray program is available in the Bradford area. In this program, fungicide sprays are applied according to the following rules:

(1) No fungicide is applied until blight appears on 1 to 2% of the leaf area. This coincides roughly with the time when blight is first detectable.

(2) After this time, apply a recommended fungicide at 7-to 10-day intervals when weather is favourable for blight; extend the interval between sprays when the weather is unfavourable for blight. Lack of rainfall or cool nights (minimum temperature less than 15°C) are unfavourable for blight.

After the leaves have closed over the rows, spray at 7-10 day intervals.

For further information, consult **OMAF Factsheet, Weather-Timed Sprays for Carrot Blight Control, Agdex 258/635,** and consult your Pest Management Advisor regarding blight assessments and blight-favourable weather.

SCLEROTINIA MOLD (of carrots, lettuce, beans and celery) — Rotate with onions, beets or spinach for 2 to 3 years. Use wider row spacings to encourage good air movement. See section on Storage.

NEMATODES — **See page 29.**

RUSTY ROOT — Follow a 3-year rotation with unrelated crops (e.g., onions). Avoid known severely infested fields. Sow seed after the soil has warmed up in the spring. Use disease-resistant cultivars, e.g., Spartan hybrids (see Cultivar Descriptions). Avoid heavy plant stands; obtain uniformly spaced plant populations with precision-seeding equipment.

VIOLET ROOT ROT — Since the fungus causing this disease persists for several years and primarily affects carrots, the best control is to rotate with other crops, (e.g., onions or cruicifers).

CARROT (Continued)

CAVITY SPOT — This disorder has been found on the main taproot of carrots grown in Ontario. Research has shown that cultivars differ is susceptibility. Select cultivars which are least susceptible. **(Consult the Annual Vegetable Cultivar Trials and Research Report published by the Muck Research Station.)** Do not over-fertilize. Obtain a soil test prior to seeding.

INSECT CONTROL

LEAFHOPPERS — Leafhoppers cause the spread of aster yellows. Apply 3 sprays at 10-day intervals in July and early August or starting as soon as aster leafhoppers appear. Also control weeds in headlands, ditchbanks, roadsides, etc., and control leafhoppers on adjacent celery and lettuce.

Spray with one of:

1. carbaryl
   Sevin XLR Plus 1.25-2.5 L (1 day)
2. [3]parathion
   [3]Parathion 15% WP 2.25 kg (15 days)

Note: Rapid killing is obtained using parathion; slower but more lasting control is obtained with carbaryl.

CARROT RUST FLY — This insect is mainly a problem in the Bradford and district marshes. Growers in other areas should consult with their Pest Management Advisor before initiating a routine spray program.

The carrot fly is monitored throughout the growing season in the Bradford area. Consult your Pest Management Advisor for information on participating in the program or for up-to-date information on timing of sprays. The first generation of flies is normally present from late May until late June, the second generation from late July until September.

Spray when recommended with one of:

Group A

1. cypermethrin
   Cymbush 250 EC 280 mL (35 days)

Group B

1. diazinon
   (i) Diazinon 50% WP 1.1 kg (10 days)
   (ii) Basudin 500 EC 1.1 L (10 days)
2. [3]parathion
   [3]Parathion 15% WP 2.25 kg (15 days)

Note: When flies are abundant, these sprays may not prevent damage to carrots growing adjacent to sheltered areas.

Cultural practices

Carrots seeded after June 1st are rarely attacked by the first generation of the carrot rust fly. Carrots harvested by early September should escape most second generation damage. If possible, avoid growing carrots immediately adjacent to sheltered areas (e.g., the canal banks of the Holland Marsh).

CARROT WEEVIL — Spray with phosmet, Imidan 50% WP 2.25 kg (40 days) when carrots are in the first true-leaf stage. Repeat once 10 to 14 days later. Do not apply more than two times per season or later than 40 days before harvest. Spraying with phosmet may also reduce the carrot fly population.

STORAGE

Mature topped carrots can be stored for up to 4 to 5 months at 0°C and a relative humidity of 90 to 95%.

Storage rots occur from infections of the carrot through wounds. Proper sanitation of the storage and handling equipment is necessary to help reduce infections. The addition of a fungicide to a dip or spray before or during the storage period will help to prevent these infections. Spray or dip *washed carrots* with a suspension of 500 g to 1 kg benomyl (Benlate) per 1000 L water before or during the storage period. Carrots for export cannot be treated, as they may be refused entry to the U.S. and other countries.

[3]*Minimum period before reentry is 7 days.*

CELERY

CULTIVARS
(Revised for 1990)

Main crop (green)

Florida 2-14	1	Tendercrisp	
Florida 683	1	Utah 52-70 strains	
Summit *(trial)*	1,2	Ventura	2
Surepak		Bishop *(trial)*	2

1: Suitable for storage
2: Tolerant to bolting; suitable for early crop

SEED TREATMENT

Buy hot water-treated seed or sow three-year-old seed to avoid seed-borne blight fungi. Treat seed before sowing with a protectant such as thiram, following manufacturer's directions.

GROWING TRANSPLANTS

Sow seed 10 to 12 weeks before field planting. About 140 grams of seed provide enough plants for one hectare when the standard field spacing is used.

CELERY (Continued)

Until the plants emerge, a temperature of 21 to 24°C is suitable. The 18 to 24°C temperature range is ample for steady growth. Night temperatures should not drop below 13°C to lessen the production of "seeders".

Plants for the early crop should not be set in the field until the danger of a prolonged cool period or actual freezing is over.

If the plants have become too tall and spindly before field setting, they can be clipped back to a height of 12 to 15 cm.

Clipped plants facilitate transplanting but well-grown, untrimmed plants are preferable because they receive less check in growth.

Plants for the late crop may be started in outdoor seedling beds if water is available for irrigation. The seed may be sown with a seed drill in rows 15 to 20 cm apart, at the rate of 80 to 110 seeds per metre of row so that the stand will not need thinning before transplanting to the field. Or, seed may be broadcast in a finely prepared bed outdoors at the rate of 15 grams per 10 m^2. However, the first method provides sturdier plants.

PREMATURE SEEDSTALK DEVELOPMENT

The development of flowering shoots, or "bolting to seed", instead of the normal growth, is mainly due to exposure of young plants to temperatures below 13°C for 10 days or more.

The amount of bolting increases as the time of exposure is lengthened. Growers producing plants, especially for the early crop, should maintain greenhouse temperatures of 16 to 21°C. The plants can be hardened, if so desired, by withholding water the last 7 to 10 days before setting in the field. Do not harden-off celery plants by lowering temperatures.

SPACING

The standard spacing is 15 cm apart in rows 80 to 85 cm apart. Celery can be direct-seeded at a rate of 1 kg per ha. Thin plants to 15 cm apart in the row.

SOIL

Muck soil is ideal for celery production because of its high moisture-holding capacity. Celery may be grown successfully on well-drained mineral soil such as a sand-loam, but irrigation may be necessary under upland conditions. Rotation with other crops is an important aid in the control of diseases and insects.

FERTILIZER

SOIL TESTS are required to determine phosphate and potash requirements. **(See tables on pages 26 and 27.)**

NITROGEN — On MINERAL SOILS apply 195 kg N/ha. On MUCK SOILS apply up to 160 kg N/ha, with 80 kg/ha preplant and the remainder applied in 2 side-dresses of 40 kg/ha as required. If manure is applied or legume sod is plowed down, reduce the nitrogen application. **(See tables on pages 16 and 18).**

APPLICATION — Apply 2/3 of the nitrogen at planting time and the remainder side-dressed in 2 or 3 applications as required.

SECONDARY AND MICRONUTRIENTS — CALCIUM deficiency results in a physiological disorder known as "black heart", in which the celery heart turns black while the outer leaves are unaffected.

Spray directly into the heart of the plant with 1.0-1.8 kg calcium/ha from calcium chloride or calcium nitrate in 1000 L water. If celery is under moisture stress, reapply once a week.

MAGNESIUM deficiency appears as chlorosis between the dark green veins of the older leaves. Some celery cultivars are inefficient in taking up magnesium from the soil. Apply a foliar spray of magnesium sulfate at rates supplying 1.0-2.0 kg magnesium/ha in 1000 L water every 10-14 days starting when the plants are about 1/3 grown.

BORON deficiency results in a physiological disease known as "cracked stem" or "cat scratches". Apply 1-3 kg boron/ha (2-6 kg/ha on muck soils) with the fertilizer, and a foliar spray of 0.1-0.3 kg boron in 1000 L water. Spray when the young plants are about 15-cm tall. A second spray application may be required.

DISEASE CONTROL

EARLY BLIGHT (Cercospora), LATE BLIGHT (Septoria) — Sterilize soil for growing seedlings in flats or frames. Rotate outdoor seedbeds. Use three-year-old or hot-water-treated seed. Start spraying or dusting when seedlings are about 5 cm high and repeat weekly throughout season. Spray with one of:

1. maneb
   Maneb 80% WP 2.25 kg (14 days)
2. mancozeb
   (i) Dithane M-45 2.25 kg (7 days)
   (ii) Manzate 200 2.25 kg (7 days)
3. anilazine
   Dyrene 50% WP 2.25-3.25 kg (1 day, wash and trim)
4. metiram
   Polyram DF 2.25 kg after transplanting (7 days)
5. zineb
   Zineb 80 WP 3.25 kg (14 days)
6. fixed copper
   Kocide 54% WP 2.25 kg (1 day)
7. chlorothalanil
   Bravo 500 1.6-2.4 L on a 3-to 5-day schedule or 2.4-4.0 L on a 8-to 10-day schedule (7 days)

ASTER YELLOWS — See Leafhoppers (Insect Control Section).

FUSARIUM YELLOWS — This fungus persists in soil for many years. Avoid introducing it by preventing the movement of infested plants or soil from other farms or areas where the disease occurs. The fungus may be introduced in or on transplants and attached soil, in infested soil carried by flood water, by wind from infested fields nearby, and by workers and their tools and implements.

If the disease is present, start seedlings in soilless media or fumigated soil and plant in fields where the disease has occurred before. Sanitation is important in preventing the spread of this disease. Avoid cultivation practices that can spread infested soil from one area to the rest of the field. Do not return celery trimmings to infested fields after harvest.

Practice a 2-to 3-year rotation with onions or lettuce to reduce spore populations in infested fields. Avoid the use of carrots in the rotation scheme.

CELERY (Continued)

Starlet cultivar is resistant to the disease while Utah 52-70 HK and Deacon are tolerant to the disease when soil population levels of the fungus are moderate. Excessive heat and drought stress may diminish this tolerance. Other cultivars are susceptible to this disease.

For more details, **Consult OMAF Factsheet, Fusarium Yellows of Celery, Agdex 251/635.**

CUCUMBER MOSAIC VIRUS — Control weeds bordering the crop area. Weeds are the source from which aphids bring in the mosaic virus. Rogue out plants if mosaic infection is noticed early in the season. Keeping aphids under control may reduce spread of the virus.

NEMATODES — **See page 29.**

INSECT CONTROL

Consult the label before combining any insecticide with fixed copper.

LEAFHOPPERS — Control leafhoppers because they spread aster yellows. Apply sprays at 7-to 10-day intervals in July and early August. Also control weeds in headlands, ditchbanks, roadsides, etc., and control leafhoppers on adjacent carrots and lettuce. To help slow down the rate of resistance, alternate the use of insecticides from the various groups.

Spray with one of:

Group A

1. cypermethrin
   Cymbush 250 EC 140 mL (7 days)

Group B

1. [3]parathion
   (i) [3]Parathion 15% WP 2.25 kg (21 days)
   (ii) [3]Parathion 800 E 275-400 mL (21 days)

Note: To avoid excessive residues, do not use parathion more than twice during the growing period.

2. malathion
   Malathion 25% WP 4.5 kg (7 days)

Group C

1. carbaryl
   Sevin XLR Plus 1.25-2.5 L (5 days)

CARROT WEEVIL

1. phosmet
   Imidan 50 WP 2.25 kg (40 days)

TARNISHED PLANT BUG — Spray with one of the materials listed for Leafhopper control, or use:

1. endosulfan*
   (i) Thiodan 50% WP 1.75 kg (14 days)
   (ii) Thiodan 4 EC 2.0 L (14 days)
   (iii) Thiodan 400 EC 2.0 L (14 days)
   **Trim the celery*

APHIDS — Spray with one of:

1. naled
   Dibrom 8.64 EC 1.7 L (4 days)
2. endosulfan*
   (i) Thiodan 50% WP 1.75 kg (14 days)
   (ii) Thiodan 4 EC 2.0 L (14 days)
   (iii) Endosulfan 400 EC 2.0 L (14 days)
   **Trim the celery*

Note: *The green peach aphid is becoming resistant to these insecticides in some areas.*

CABBAGE LOOPER — Spray when loopers first appear with one of:

1. Bacillus thuringiensis
   Thuricide 4.5 L (0 days)
2. endosulfan*
   (i) Thiodan 50% WP 1.75 kg (14 days)
   (ii) Thiodan 4 EC 2.0 L (14 days)
   (iii) Endosulfan 400 EC 2.0 L (14 days)
   **Trim the celery*

[3]*Minimum period before reentry is 7 days.*

STORAGE

Celery badly damaged by frost, disease, or handling should not be stored. A relative humidity of 95 to 98% and a temperature of 0°C are ideal. Celery should be stored in a room that is free from odours because the plant absorbs foreign flavours. Field heat should be removed, by hydro cooling or vacuum cooling, before placing in large storage rooms.

Handling diseased or healthy plants will prevent the development of severe skin rashes in some individuals.

CORN (SWEET)

CULTIVARS

TYPES OF SWEET CORN CULTIVARS

Sweet corn cultivars are changing very quickly because of the new high-sugar components introduced by the seed companies over the last few years.

The major types of sweet corn are grouped according to the "gene" responsible for their level of sweetness.

REGULAR SWEET CORN — are cultivars that have been grown traditionally containing the "su gene". These cultivars produce an average amount of sugar, but the sugar changes to starch rapidly after harvest if the cob temperature is not reduced quickly by way of refrigeration.

SUGAR ENHANCED SWEET CORN — are cultivars containing the "se gene". These cultivars produce a higher amount of sugar than most "su" types. Cultivars with the "se gene" also convert sugar to starch like regular sweet corn, but because they have higher sugar levels to begin with, they will retain a sweet flavour longer after harvest. Individual corn kernels on cultivars containing the "se gene" tend to have thinner pericarps (skin) over each kernel and therefore must be handled more gently. They are less likely to withstand a mechanical harvester.

SUPERSWEET SWEET CORN — are cultivars containing the "SH_2 gene". These cultivars do not convert sugar to starch readily and therefore stay sweet for a longer time after they reach harvest maturity. This allows more time for growers to market the corn. Also, SH_2 types retain their sweetness longer in the consumer's home. This does not mean SH_2 types can be held indefinitely — or that it doesn't need rapid cooling after harvest — rather, SH_2 cultivars are still living entities and are continuing to "burn up" stored sugars. As maturity advances, the kernels develop thicker pericarps (skins). This means that they become more chewy as they become over mature. As a result, SH_2 types also benefit from rapid cooling after harvest to slow down these changes.

The se and SH_2 cultivars express their high sugar levels best when grown in isolation, away from both field corn and other types of corn. Isolation is most critical with cultivars containing the SH_2 gene: e.g., Extra Early Super Sweet. Isolation can be obtained by growing these cultivars 75 metres away from the other corn. These cultivars can also be considered isolated if the corn grown within 75 metres has a 2-week difference in tasseling time.

Note

Because of lower seed vigour and poorer germination with cultivars containing both the se gene and particularly the SH_2 gene:

- plant when soil temperature is above 18°C
- use seeding rates 20% higher than normal
- plant shallow, e.g., 1.5 cm
- plant into moist ground or irrigate after planting
- handle and plant SH_2 seed gently, since the kernels can crack easily

SCHEDULED PLANTING

Days-to-maturity vary according to the temperature. The same cultivar may require 85 days to reach maturity if planted in early May but only 65 days if planted in mid-June. It will also mature later in cooler regions of the province. To assure a regular supply of sweet corn, corn plantings should be scheduled. **Consult OMAF Factsheet, Scheduling Plantings of Sweet Corn, Agdex 253/22.**

SEEDING AND SPACING

Eleven to seventeen kilograms of seed are required to plant one hectare, depending on seed size. Where small seed is used the lower amount is sufficient. Minimum soil temperature for germination depends on the cultivar and its gene type. In general, su cultivars require 13°C, se's 16°C, and SH_2's 18°C.

EARLY CULTIVARS — Rows as close as 75 cm, plants 20 to 22 cm apart.

TALL, LATE CULTIVARS — Rows 95 cm apart, plants 22 to 25 cm apart.

FERTILIZER

SOIL TESTS are required to determine phosphate and potash requirements. **(See tables on pages 26 and 27.)**

NITROGEN — 90 kg N/ha is recommended. If manure is applied or legume sod is plowed down reduce the nitrogen application. **(See tables on pages 16 and 18.)**

APPLICATION — A portion of the nitrogen and phosphorus required should be applied at seeding in one of two ways:

1. In a band 5 cm to the side and 5 cm below the seed. The rate of application in the band should not supply more than 75 kg nitrogen/ha or a total of 120 kg of nitrogen plus potash (K_2O) per hectare in 75-cm rows. If urea is the nitrogen source, not more than 40 kg nitrogen or 80 kg of nitrogen plus potash/ha should be applied in 75-cm rows.
2. In a band directly with the seed. With this placement, not more than 9 kg nitrogen plus potash (K_2O)/ha should be applied in 75-cm rows. A major portion of the nitrogen should be applied preplant or side-dressed before the corn is 30 cm high. A major portion of the phosphate and potash may be broadcast and worked in either in the fall or before seeding in the spring.

MICRONUTRIENTS — ZINC deficiency occurs occasionally in corn in Ontario. Visual symptoms on the leaves are the best means of determining deficiency but soil tests are also useful. Where zinc is required it may be applied to the soil mixed in the fertilizer at rates supplying 4 to 12 kg zinc/ha. The higher rate should be sufficient for up to 3 years. Not more than 4 kg zinc/ha should be banded at seeding. Zinc may be applied as a spray at rates supplying 0.3-0.7 kg zinc/ha in 300 litres of water. A wetting agent should be added.

BIRD AND ANIMAL CONTROL

RED-WINGED BLACK BIRDS AND CROWS — Acetylene exploders are effective but birds will soon resume feeding when exploders are not operating. For full effectiveness locate them above the cornstalks, and move them around frequently. Constant patrolling and shooting during morning and evening feeding periods is effective but expensive. Plant away from marshy and wooded areas. Cultivars with ears well covered by husks are somewhat resistant to blackbirds.

CORN SWEET (Continued)

Av-Alarm electronic bird-scaring devices have sometimes been used successfully to repel large flocks of birds from fields of sweet corn.

RACCOONS AND SKUNKS — Shoot or trap in season. Plant the crop away from wooded areas. An electric fence with three strands placed at 8-to 10-cm intervals from the ground has given satisfactory control.

DISEASE CONTROL

SEED DECAY — Treat seed with thiram or captan seed protectant.

LEAF BLIGHTS, STALK ROTS, EAR ROTS — Rotate corn with unrelated crops such as peas, carrots, potatoes, beans and tomatoes. Plow under old cornstalks and leaves. Maintain well-balanced soil fertility.

COMMON SMUT — Crop rotation (4 years) may be helpful. Plant sweet corn following a legume such as alfalfa, clover, or beans. Do not plant sweet corn after field corn.

HEAD SMUT — This disease was first found in Ontario in 1979 and is easily confused with common smut. Follow recommendations given for common smut. The head-smut fungus survives in the soil for several years. For detailed information, **consult OMAF Factsheet, Head Smut of Corn, Agdex 111/632.**

INSECT CONTROL

SEED MAGGOTS AND WIREWORMS — Treat seed with diazinon, lindane and a fungicide. **See Chemical Seed Treatment, page 31.**

EUROPEAN CORN BORER — The initiation of a spray program is based on the presence of pinhole feeding detected through field inspections. The time to look for pinhole feeding is determined by the presence of corn borer adults, a service provided in Ontario **(consult your local Agriphone)**, and the stage of development of the corn. Sweet corn is susceptible to corn borer damage from the last whorl stage (tassels just emerging) until harvest. Apply an insecticide when pinhole feeding is observed in at least 5% of the plants. Depending on the stage of growth, direct the spray into the whorl until the tassels are completely emerged, then direct sprays toward the ear zone.

Application at 5-day intervals usually gives satisfactory control. This interval may vary with temperature and material used (consult manufacturer's label directions). Early corn in the 2-generation area may only require 2 applications.

There are 2 generations of corn borer per year in Essex, Kent, Elgin, and Norfolk counties. Generally there is only one generation per year throughout the rest of the province. However, in a overlap area in counties bordering Essex, Kent, Elgin, and Norfolk counties, two generations of corn borer may be present. In the 2-generation area, corn borer adults are most abundant in June and August, with August having the greater number. In the one-generation area, most corn borer adults are present in July.

Spray with one of:

1. permethrin
   (i) Ambush 500 EC 200-275 mL (1 day)
   (ii) Pounce 384 EC 275-375 mL (1 day)
2. cypermethrin
   (i) Cymbush 250 EC 280 mL (5 days)
   (ii) Ripcord 400 EC 175 mL (5 days)
3. carbaryl
   Sevin XLR Plus 2.5-4.0 L (1 day)
4. [2]carbofuran
   [2]Furadan 480 F 1.1 L (7 days)
5. methomyl
   [1]Lannate L 2.6 L (3 days) (Shorten spray interval to 3 days under high pressures and rainy weather conditions.)

FALL ARMYWORM — There is an increased awareness of fall armyworms found in sweet corn during August and September. The dark-striped larvae with small bristly hairs are first observed in the silks. There can be as many as 6 to 8 fall armyworms attacking the tips of the cob, rendering the ear unmarketable, especially for the fresh market. Effective control has been obtained by using one of the synthetic pyrethroids directed at the ear zone. Use one of the recommended materials listed under corn earworms.

APHIDS — Methomyl and parathion, as applied to control European corn borer, will also provide some control of aphids.

CORN EARWORM — Corn earworm does not overwinter in Ontario but is blown in from the United States. It occasionally reaches damage levels beginning in mid-August. Apply 4 sprays at 4-day intervals (3-day intervals in hot weather), starting when 25% of the ears show silk. For corn earworm activity information, call the Agriphone of the Horticultural Crop Advisor.

Direct spray to ear zone using one of:

1. cypermethrin
   Ripcord 400 EC 175 mL (5 days). Maximum of 3 ground applications or 2 aerial applications per year.
2. permethrin
   (i) Ambush 500 EC 200-275 mL (1 day)
   (ii) Pounce 384 EC 275-375 mL (1 day)
3. [1]methomyl
   [1]Lannate L 1.8-2.6 L (3 days)

CORN ROOTWORM — Where corn rootworm has been a problem, crop rotation is recommended. For adult control, products used for European corn borer control will reduce populations of rootworm adults.

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[1] *Minimum period before reentry is 24 hours.*
[2] *Minimum period before reentry is 48 hours.*

BEE WARNING

Bees often visit sweet and field corn to collect pollen. Where spraying is being done, bee poisoning may result. **Carbaryl, carbofuran and permethrin are highly toxic to bees** but carbaryl is the most damaging, since it is carried to the hive and poisons the brood. If bees are in the area, advise the local beekeepers of spraying activity and do not use carbaryl. **Your local Agricultural Representative has a list of beekeepers in your area.** Damage to bees is reduced when sprays are applied in early morning or late evening when bees are not foraging. Do not treat when the wind is blowing. Avoid spray drift to roadsides and adjacent fields where plants might be in bloom.

CUCUMBER (FRESH MARKET), MUSKMELON, WATERMELON, PUMPKIN AND SQUASH

VINE-CROP CULTIVARS
(Revised for 1990)

CUCUMBER (listed alphabetically)	
Dasher II	Raider
Highmark II	Southern Set
Marketmore 76	Slicemaster
Medalist	Sprint 440
Monarch	Ultra Slice
MUSKMELON	
Burpee Hybrid	Roadrunner *(trial)*
Market Star[1]	Canada Gem Hybrid
Early Dawn	Saticoy Hybrid[1]
Rising Star	Nova
Samson[1]	Summet[1]
	Supermarket[1]
WATERMELON	
Dixie Lee	*Long-Oblong for*
Sugar Baby	*long-season areas*
Crimson Sweet	Royal Jubilee
Blue Belle	Charleston Gray 113
	Royal Sweet
	Prince Charles
PUMPKIN	
Funny-Face	Spooky
Connecticut Field	(semi-bush, home use)
Small Sugar (home use)	Early Cheyenne Pie
Jackpot Hybrid (Hallowe'en)	(home use in northern areas)
SQUASH (WINTER)	
Waltham Butternut	Royal Acorn
Hercules	Hubbard (Golden, Blue, Green)
Kindred	Delicious
Buttercup	Boston Marrow
SQUASH (SUMMER)	
Cocozelle	Zucchini Select
White Bush Scallop	Zucchini Elite

[1]*Resistant to powdery mildew*

Consult **OMAF Factsheet, Muskmelon Production, Agdex 256/20.**

SEED TREATMENT

Treat seed with a fungicide such as thiram or captan according to the manufacturer's directions.

PLANTING MELONS

Early muskmelon crops are usually started in hotbeds or greenhouses 5 weeks before transplanting outdoors.

About three seeds are sown 2.5 cm deep in sterile soil in 10 x 10-cm bands, or 10-cm clay, plastic, or peat pots. Seedlings are thinned to two per pot.

Germination temperature should be 27 to 29°C until seedling emergence, then 16 to 18°C minimum night temperature.

The plants should be set in the field with a starter solution. Watermelons may be treated in a similar manner.

MULCHING MELONS

Mulching melon transplants or seeding directly through mulches of black polyethylene or plastic-coated paper has proven beneficial because of an increase in early and total yield. These mulches also conserve moisture, control weeds, accelerate maturity by increasing soil temperature, and reduce fruit rots.

The polyethylene films are usually black or some other dark colour in order to control weeds. If a clear film is used, a preemergence herbicide must be incorporated into the soil before laying the mulch. Mulching materials are usually 1.5 mm thick and usually come in 90- or 120-cm wide rolls. A tractor-mounted machine lays the mulch and covers the edges with soil. If the rows are 1.9 m to 2.2 m apart, 5,260 m or 4,550 m respectively, are required per ha.

Commercial machines are available to transplant plants in peat pots through the mulch. There are also seeders that can plant through the mulch.

The use of photo-degradable mulches that disintegrate in the presence of light eliminates the need for removing the mulch from the soil after harvest.

SEEDING AND SPACING

About 2.2 kg of seed are required to produce enough cucumber and muskmelon transplants for one hectare. For direct seeding of cucumbers and melons, 4.5 to 5.5 kg of seed per hectare are required.

SQUASH AND PUMPKIN seeding rates vary somewhat with seed size. Large-seeded cultivars such as Blue Hubbard will require 3.5 to 4.5 kg per hectare and small-seeded cultivars such as Butternut 1 to 1.5 kg per hectare.

CUCUMBER — Rows 1.2 to 1.8 m, plants 30 cm apart.

MUSKMELON — Rows 1.5 to 1.8 m, plants 60 to 120 cm apart.

WATERMELON — Rows 1.8 to 2.5 m, plants 90 to 120 cm apart.

PUMPKIN (STANDARD) AND WINTER SQUASH — Rows 1.8 to 2.5 m, plants 90 to 120 cm apart.

PUMPKIN (BUSH) AND SUMMER SQUASH — Rows 90 to 120 cm, plants 60 to 90 cm apart.

POLLINATION

All the vine crops depend on insects to transfer pollen from the male to the female blossoms, which are borne separately on the same plant. In small plantings there may be sufficient native pollinating insects to perform this service. In large plantings, the grower would be well advised to introduce one colony of honeybees for every hectare to ensure adequate pollination. Insecticides will poison bees. **See warning on page 47 Re: Bee Poisoning.** **Consult OMAF Factsheet, Pollination of Vine Crops, Agdex 256/ 26.**

CUCUMBER (FRESH MARKET), MUSKMELON WATERMELON, PUMPKIN, AND SQUASH (Continued)

FERTILIZER

SOIL TESTS are required to determine phosphate and potash requirements. **(See tables on pages 26 and 27.)**

NITROGEN — Apply up to 110 kg N/ha. If manure is applied or legume sod is plowed down, reduce the nitrogen application. **(See tables on pages 16 and 18.)**

APPLICATION — Broadcast 65 kg N/ha and all of the phosphate and potash required before planting and work in. Alternatively, up to 100 kg of ($N + K_2O$)/ha can be applied in a band, 5 cm to the side and 5 cm below the seed at planting with the remainder of the fertilizer broadcast before planting.

The remainder of the N should be side-dressed before the vines begin to run, and on sandy soils a second application may be necessary after the vines begin to run, especially following heavy rains.

IRRIGATION — If the nitrogen is applied through the irrigation system, no more than 20 kg N/ha per application should be used.

DISEASE CONTROL

DAMPING-OFF — Treat seed with a captan or thiram seed protectant. Sterilize soil for growing seedlings.

BACTERIAL WILT — The causal bacteria overwinter in and are spread by cucumber beetles which feed on cucumbers and other vine crops. Plants may become infected soon after they emerge when the crop is field seeded, or after transplants are set in the field and are susceptible for the following 3 to 5 weeks. Beetles must be controlled (see Cucumber Beetles).

ANGULAR LEAF SPOT (cucumber) — It is not possible to completely control this disease with chemical sprays. A reduction in disease severity may be achieved by spraying with a fixed-copper fungicide. Repeat at weekly intervals in wet weather. Do not work in crop when foliage is wet.

1. fixed copper
   Kocide 54% WP 3.25 kg (1 day)

FUSARIUM WILT (muskmelon) — Sterilize soil for melon transplants. Grow Fusarium-resistant cultivars in infested soils (consult seed catalogue).

MOSAIC (VIRUS) — Grow cultivars reported to be highly resistant to mosaic (cucumber cultivars show a range of resistance). Consult seed catalogue. Since the virus is transmitted by aphids, spray or dust to control them (see Aphids). Because the virus overwinters in such perennial weeds as milkweed, ground cherry, pokeweed and motherwort, destroy nearby weeds in fencerows and waste areas.

SCAB (cucumber) — Where susceptible cultivars are grown, scab is often serious. Do not plant cucumbers following cucumbers. Beyond the seedling stage spray with one of:

1. chlorothalanil
   Bravo 500 4.8 L (1 day)
2. mancozeb
   (i) Mancozeb 80 WP 3.25 kg (5 days)
   (ii) Dithane M-45 3.25 kg (5 days)
   (iii) Manzate 200 3.25 kg (5 days)
3. benomyl
   Benlate 50 WP 550-850 g + mancozeb (see above)

ANTHRACNOSE (muskmelon and watermelon) — Do not plant melons following melons. Spray seedlings as described above for control of scab on cucumbers. Beyond the seedling stage spray with one of:

1. captafol
   Difolatan 480 F 2.75-5.0 L (1 day)
2. anilazine
   Dyrene 50% WP 3.75 kg (1 day)
3. chlorothalanil
   Bravo 500 4.8 L (1 day)
4. mancozeb
   (i) Mancozeb 80 WP 3.25 kg (5 days)
   (ii) Dithane M-45 3.25 kg (5 days)
   (iii) Manzate 200 3.25 kg (5 days)

POWDERY MILDEW — Some cucumber and muskmelon cultivars are moderately resistant to mildew. As soon as mildew appears, spray with one of the following at 8- to 10-day intervals:

1. chlorothalanil
   Bravo 500 4.8 L (1 day)
2. benomyl
   Benlate 50 WP 550-750 kg + mancozeb (see above for anthracnose) (5 days)

ALTERNARIA LEAF SPOT — This disease is often prevalent in muskmelons. The oldest leaves are infected first. Sprays applied to control scab and anthracnose are somewhat effective.

NEMATODES — **See page 29.**

INSECT CONTROL

Bee Warning

These insecticides, except rotenone, poison bees. Apply insecticides other than rotenone early in the day or in the evening when bees are not working in the field. If hives are in the crop, remove them when treating the field.

SEED MAGGOTS, WIREWORMS AND SEED DECAY — Treat seed with diazinon, lindane, and a fungicide. See Chemical Seed Treatment, page 31.

CUTWORMS — See page 30.

CUCUMBER (FRESH MARKET), MUSKMELON WATERMELON, PUMPKIN, AND SQUASH (Continued)

CUCUMBER BEETLES — Spray or dust when plants are breaking through (repeat if beetles reappear) with one of the following:

Spray:

1. endosulfan
   (i) Thiodan 50% WP 1.1 kg (2 days)
   (ii) Thiodan 4 EC 1.5 L (2 days)
   (iii) Endosulfan 400 EC 1.5 L (2 days)
2. [2]azinphos-methyl
   (i) Guthion 240 SC 2.25 L (6 days)
   (ii) APM 50 WP 1.1 kg (6 days)

Dust:

1. rotenone
   Rotenone 1% 40 kg (1 day)

Or use a commercial cucumber or melon dust containing an insecticide and fungicide.

APHIDS — Spray with one of the following which are listed in order of best control:

1. endosulfan
   (i) Thiodan 50% WP 1.1 kg (2 days)
   (ii) Thiodan 4 EC 1.4 L (2 days)
   (iii) Endosulfan 400 EC 1.5 L (2 days)
2. malathion
   Malathion 25% WP 3.25-4.5 kg (1 day, 3 days pumpkin)
3. [2]oxydemeton-methyl
   [2]Metasystox-R 240 SC 1.75-2.25 L (14 days, 7 days watermelon)

SQUASH BUG (more common on squash and pumpkin) — Use one of the following:

Spray:

1. rotenone
   Rotenone 5% WP 4.5 kg (1 day)
2. methoxychlor
   Methoxychlor 50% WP 3.25 kg (1 day)

Dust:

1. rotenone
   Rotenone 1% 40 kg (1 day)

SQUASH VINE BORER (on squash) — Four insecticide applications one week apart starting in late June are required. Treat base of plants thoroughly with one of the following:

Spray:

1. rotenone
   Rotenone 5% WP 4.5 kg (1 day)
2. endosulfan
   (i) Thiodan 50% WP 1.1 kg (2 days)
   (ii) Thiodan 4 EC 1.4 L (2 days)
   (iii) Endosulfan 400 EC 1.5 L (2 days)

Dust:

1. rotenone
   Rotenone 1% 40 kg (1 day)

Butternut squash is resistant to squash vine borer.

THRIPS AND LEAFHOPPERS — Spray or dust with methoxychlor, rotenone, or malathion at rates given for other insects.

TWO-SPOTTED SPIDER MITE — Spray with:

1. dicofol
   Kelthane 35% AP 1.1-1.75 kg (2 days)

SAP BEETLES (melons) — Beetles infest and damage ripening fruit where the stem is attached to the vine and where the skin is diseased or injured. To reduce beetle injury, harvest the melons as often as possible at the half-slip stage. Remove all damaged fruit and culls from the field.

CORN ROOTWORM BEETLES — Materials used to control cucumber beetles will provide short-term control of corn rootworms.

TARNISHED PLANT BUG — Endosulfan, when used for the control of cucumber beetles will provide some control of tarnished plant bug.

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[2]*Minimum period before reentry is 48 hours.*

CURING AND STORING PUMPKIN AND SQUASH

Most pumpkins do not keep as well as hard-shelled winter squashes but if properly handled they can be kept until after Christmas. All winter squashes should be well-matured, carefully handled and free from injury or decay when stored. Unlike most other vegetables, squashes and pumpkins require warm, fairly dry storage with good air circulation. The fruit can be placed, preferably on racks, leaving a small space between each fruit or they can be placed in bulk bins and baskets. Pumpkins and winter squashes are best stored at 10-13°C with a relative humidity (RH) of 50-70%. Temperatures that are too low in storage will cause a very rapid breakdown and rotting of fruit.

Butternut squashes should keep 2 to 3 months at 10°C with 50% RH after which time spoilage and shrinkage increase. Weight loss should be kept below 15%. Butternut squashes should keep at least 3 weeks. Hubbard squashes can be stored up to 6 months at 10-13°C with 70% RH.

Curing the fruit for 10-20 days at 24°-27°C can decrease the higher water content of the fruit and improve the eating quality. Butternut, Hubbard and Delicious cultivars respond to this treatment but storage life may be shortened. Curing acorn-type squashes decreases the storage life and eating quality.

CUCUMBER (PROCESSING)

CULTIVARS
(Revised for 1990)

Hand-Pick		Once-Over
Earlipik 14	Score	Flurry
Premier	Flurry	Pik-Rite
Pioneer	Carolina	Spear-It
Pik-Rite	Fancipak	Calypso
		Napoleon

All the cultivars listed are hybrids that have a predominately female flowering habit. A true gynoecious cucumber bears only female flowers. However, not all hybrids produce 100% female flowers. As many as 80% of the plants of many new hybrids may have some male flowers in Ontario fields. Our environment (e.g., daylength and temperatures) may be responsible for the presence of male flowers on these hybrids. From 10 to 15% of the seed sold as a gynoecious hybrid is a standard or monoecious cultivar, added as a pollinator. For satisfactory fruit set, 10 to 20% of the plants should contain a large number of male flowers.

The cultivars listed are recommended based on their suitability for either hand-pick or once-over mechanical harvesting. The hand-pick cultivars have performed well in trials and on growers' fields over the past several years. They include black and white-spined cultivars. Black-spined cultivars turn yellow as they reach maturity or if they are under stress. White-spined cultivars maintain their green color independent of stage of maturity and are preferred for once-over mechanical harvesting. The once-over cultivars listed are white-spined. All of these cultivars were bred especially for once-over harvesting of high plant populations.

SEED TREATMENT

See Cucumber (Fresh Market). Seed provided by processors is usually treated with a seed protectant.

PLANTING

Pickling cucumbers are usually field-seeded from late May to early June for the hand-pick crop but for once-over mechanical harvesting, seeding can be done until mid-July. Quick uniform emergence is essential to avoid uneven stands and stands weakened by insects and disease. Because of a more uniform depth of seeding and spacing of the seed, precision seeding tends to reduce plant stress and promote more uniform crop emergence and development. Cucumber seeds will not germinate at a soil temperature below 10°C, germinate slowly at 20°C, with fastest germination at 25 to 30°C soil temperature. Delay seed sowing until the soil temperature is 15°C or higher. Seeding depth will vary depending on moisture. A soil cover of 20 to 25 mm is usually adequate. Cucumber seed should never be planted deeper than 25 mm.

SPACING

For the hand-harvested crop, rows are usually spaced 1.1 to 1.2 m apart with 6 to 10 plants per metre of row. This gives plant populations ranging from 50,000 to 90,000 plants per ha. These spacings require from 1.7 to 3.0 kg of cucumber seed per ha. With average germination conditions, 1.0 kg of cucumber seed will give approximately 30,000 plants. Close spacing, rows 75 cm apart, have been successfully used by some growers. In general, the closer the spacing, the higher the yield. However, very close spacing may present problems at harvest due to excessive vine, depending on cultivar, soil type and amount of rainfall.

For the once-over machine-harvested crop, the plant population for optimum yield will depend on soil type and availability of irrigation. Without irrigation, populations of 150,000 per ha are adequate. This population can be achieved by spacing rows 70 cm apart with 10 plants per metre of row and will require 5.0 kg of seed per ha. Higher populations, up to 200,000 plants per ha, can be achieved by spacing rows 50 cm apart with 10 plants per metre of row, requiring approximately 7.0 kg of seed per ha.

POLLINATION

With the use of hybrids and high plant populations, the provision of bees for pollination becomes extremely important. One honey-bee colony per 50,000 plants during the blooming period is suggested. Insecticides will poison bees. **See warning Re: Bee Poisoning on page 47. Consult OMAF Factsheet, Pollination of Vine Crops, Agdex 256/26.**

FERTILIZER

SOIL TESTS are required to determine phosphate and potash requirements. **(See tables on pages 26 and 27.)**

NITROGEN — Apply up to 110 kg N/ha. If manure is applied or legume sod is plowed down, reduce the nitrogen application. **(See tables on pages 16 and 18.)**

APPLICATION — Broadcast 65 kg N/ha and all of the phosphate and potash required before planting and work in. Alternatively, up to 100 kg of ($N + K_2O$)/ha can be applied in a band, 5 cm to the side and 5 cm below the seed at planting with the remainder of the fertilizer broadcast before planting.

The remainder of the N should be side-dressed before the vines begin to run, and on sandy soils a second application may be necessary after the vines begin to run if rainfall is excessive.

IRRIGATION — If the nitrogen is applied through the irrigation system, no more than 20 kg N/ha per application should be used.

DISEASE CONTROL

ANGULAR LEAF SPOT — Persistence of angular leaf spot in the field is a major problem. Infection of fruit is readily visible in the processed product. See Cucumber (Fresh Market).

SCAB — Grow scab-resistant cultivars. All pickling cultivars listed above are scab resistant. Also see Cucumber (Fresh Market).

OTHER DISEASES — See Cucumber (Fresh Market).

INSECT CONTROL

See Cucumber (Fresh Market).

EGGPLANT

CULTIVARS
(Not revised for 1990)

Jersey King	Burpee	Black Magic

SEED TREATMENT

Sow hot-water-treated seed **(see page 31)**. Before sowing, dust seed with thiram seed protectant.

SEED AND SPACING

Two hundred to three hundred grams of seed will produce enough plants for one hectare with rows 90 to 120 cm apart, and plants 45 to 60 cm apart.

GROWING THE PLANTS

Because eggplant requires a long growing season, it is started in a greenhouse or hotbed. The seed is sown in shallow flats of soil 9 to 10 weeks before field transplanting because the seed germinates slowly. Germinate seed at 27 to 29°C in flats of sterilized soil or whatever sterile medium is used for growing seedlings. It is important that the young plants are not checked in growth by cool temperatures, drought, cold drafts, or other causes. It is advisable to transplant the young plants to pots or bands before field setting to keep transplanting shock to a minimum.

Eggplants are hardened in the same way as peppers, except that a higher temperature (18 to 21°C) is maintained.

FERTILIZER

SOIL TESTS are required to determine phosphate and potash requirements. **(See tables on pages 26 and 27.)**

NITROGEN — Apply up to 70 kg N/ha. If manure is applied or legume sod is plowed down, reduce the nitrogen application. **(See tables on pages 16 and 18.)**

APPLICATION — Broadcast 35 kg N/ha and all of the phosphate and potash required before planting and work in. The remainder of the N should be side-dressed, 3 to 4 weeks after field setting.

STARTER SOLUTION — At transplanting apply a starter solution high in phosphorus such as 1 L of 10-34-0 per 100 L of water or 1 L of 6-24-6 per 75 L of water. Under high temperature conditions or in dry sandy soils, reduce the amount of fertilizer by one-half but continue to use the same volume of water. This will reduce the risk of crop injury under these growing conditions.

DISEASE CONTROL

DAMPING-OFF — See Seed Treatment. Sow and transplant in steamed or fumigated soil. Drench flats at time of first watering with captan 50% WP (see label). When first true leaves develop, spray with captan or ziram and repeat every 7 to 10 days. Apply sufficient spray to wet the plants and run down the stems **(See Damping-Off, page 31.)**

VERTICILLIUM WILT — Sow and transplant in steamed or fumigated soil. Do not plant in fields where Verticillium wilt has been present unless the soil is treated with Vorlex 450 L/ha, according to manufacturer's directions. Good weed control is an important part of wilt control. Wilt may be serious following peppers, tomatoes, eggplant and potatoes.

PHOMOPSIS BLIGHT — Avoid planting in infested fields for 3 years.

NEMATODES — **See page 29.**

INSECT CONTROL

FLEA BEETLES — Spray plants just before field setting with one of the following insecticides. Repeat in the field if beetles appear.

1. endosulfan
   (i) Thiodan 50% WP 1.1 kg (2 days)
   (ii) Thiodan 4 EC 1.5 L (2 days)
   (iii) Endosulfan 400 EC 1.5 L (2 days)
2. carbaryl
   Sevin XLR Plus 1.25 L (2 days)

APHIDS — Spray with one of:

1. endosulfan
   (i) Thiodan 50% WP 1.1 kg (2 days)
   (ii) Thiodan 4 EC 1.4 L (2 days)
   (iii) Endosulfan 400 EC 1.5 L (2 days)

The green peach aphid is resistant to these insecticides in some areas.

TARNISHED PLANT BUGS — Monitoring for tarnished plant bug should begin at time of flowering.

Spray:

1. dimethoate
   Cygon 480 E 0.7-1.7 L (7 days)

COLORADO POTATO BEETLE

Spray:

1. carbaryl*
   Sevin XLR Plus 1.25 L (2 days)

**Repeat as necessary.*

GARLIC

CULTIVARS

Cultivated garlic plants do not produce true seed. All garlic is propagated vegetatively. Two types of garlic are grown in Ontario and are described as either "hardneck" or "softneck". For seed sources, consult a Horticultural Crop Advisor.

SEEDING AND SPACING

The optimum planting date is between September to late October. To estimate the planting date, use the average date for the first fall frost for the area in which garlic is to be grown and begin planting on this date. See Table 2.

RATE — 700 to 1000 kg of cloves per hectare.

DEPTH OF PLANTING — Allow for 3 to 5 cm between the soil surface and the top of the clove.

ROW SPACING — Row centers of 20 cm or more, depending upon equipment available; 7 to 12 cm apart within the row.

FERTILIZER

To establish pH, phosphorus and potassium requirements, a soil test should be used. pH, phosphorus and potassium levels should be ammended prior to fall planting. Phosphorus and potassium requirements are similar to onions.

NITROGEN — On mineral soils, a total of 110 kg/ha is required. Calcium nitrate or ammonium nitrate are the preferred sources. Half of the nitrogen should be applied as soon as the garlic plants begin to grow in the spring. The rest of the nitrogen should be applied in 2 to 3 side-dresses at 3-week intervals.

SOILS

Garlic can be grown on a wide range of soil types providing that the soils are well-drained, deep and fertile. Soils with good organic matter content are preferred due to the increased moisture and nutrient holding capacity. Extremely heavy soil types should be avoided. Soil pH should range from 6.0-7.5.

IRRIGATION

Garlic is shallow-rooted and is sensitive to moisture stress. For most soil types, approximately 2.5 cm of water is required per week. On very dry sandy soils, as much as 5.0 cm is required weekly.

DISEASE CONTROL

PENICILLIUM OR GREEN MOLD DISEASE — Green mold disease, caused by the fungus Penicillium, attacks cloves which have been damaged prior to planting. Affected cloves may fail to emerge in the spring, or may produce weak, stunted plants which soon die. Plant only clonal cultivars known to be vigorous under Ontario growing conditions. Avoid damaging the seed cloves, especially during the cracking procedure. Many mechanized cracking devices cause excessive amounts of clove damage. Crack the seed immediately before it is to be planted. The cracked cloves may be treated with:

1. iprodione
   Rovral 50 WP 4 g/L of water

Note: Dip cloves into Rovral suspension prior to planting.

INSECT CONTROL

APHIDS AND THRIPS

1. malathion
   (i) Malathion 25 WP 4.25 kg (3 days)
   (ii) Malathion 500 E 2 L (3 days)

ONION MAGGOTS

1. chlorpyrifos
   Lorsban 4E 3.5 L in 1000 L of water (50 days)

Note: Apply as a drench in the spring over the row on newly emerged plants.

For further details, **consult OMAF Factsheet, Garlic Production in Ontario, Agdex 258/13.**

Handy Metric Conversion Factor

Litres per hectare x 0.4 = litres per acre
Kilograms per hectare x 0.4 = kilograms per acre

LETTUCE

CULTIVARS
(Revised for 1990)

CRISPHEAD

TRANSPLANTS
Ithaca

SEEDED
Ithaca (early, mid, late)
Mesa 659 (late)
Montello (mid, late)
Green Lake (mid, late)
Salad Crisp *(trial)*

BOSTON AND BUTTERHEAD
Buttercrunch
Summer Bibb
Dark Green Boston
Citation

LEAF
Black-Seeded Simpson
Grand Rapids Forcing
Deep Red

COS OR ROMAINE
Paris Island Cos
Valmaine Cos
Signal
Green Towers
Tall Guzmaine *(trial)*

TEMPERATURE

Lettuce is a cool-weather crop and makes its best growth at temperatures between 16 and 18°C. Production is limited on mineral soils to the transplanted early crop and the seed-sown late crop. On muck soils, in cooler areas such as Bradford, lettuce may be produced throughout the growing season.

Properly hardened transplants, when set in the field in the early spring, can tolerate temperatures as low as −7°C. For the late crop on both muck and mineral soils, seeding time is important. If plants are immature when the first frost occurs, they will recover. Wrapper leaves on mature heads are very susceptible to frost and can only be marketed at a lower grade.

Germination occurs even at 4°C. At very high soil temperatures (27°C or above), germination is delayed.

SEED TREATMENT

See Chemical Seed Treatment (page 31).

PLANTING

SEEDBEDS — About 275 grams of seed sown thinly in rows in flats should ensure sufficient plants to set one hectare. About 2 weeks later, transplant about 5 cm apart in peat pots, plant bands, or flats.

Harden plants and thoroughly soak soil with starter solution (20-20-20) before transplanting in the field.

DIRECT-SEEDING — Sow seed in spring as soon as soil is ready. The rate is 1 to 2 kg per hectare.

Use coated or pelleted seed with a precision seeder. The stand and germination are more uniform, thinning costs are reduced, and higher percentages of cut are realized at harvest time.

SPACING — Leaf and butterhead cultivars, 20 to 30 cm in rows about 30 cm apart. Crisphead lettuce, 35 to 45 cm apart in rows about 40 cm apart.

THINNING — Thin when 2 or 3 leaves have formed.

FERTILIZER

SOIL TESTS are required to determine phosphate and potash requirements. **(See tables on pages 26 and 27.)**

NITROGEN — On MINERAL SOILS apply up to 110 kg/ha and on MUCK SOILS apply up to 120 kg/ha. If manure is applied or legume sod is plowed down, reduce the nitrogen application. **(See tables on pages 16 and 18.)**

APPLICATION — On MINERAL SOILS broadcast half the nitrogen before planting and work in. Side-dress the balance 3 weeks after transplanting to the field or after thinning the seeded crop. On MUCK SOILS broadcast nitrogen at 70 - 90 kg/ha before planting and side-dress the remainder when the heads begin to form.

MICRONUTRIENTS — COPPER deficiency may show up on acid peat and muck soils. Copper may be mixed with the fertilizer and applied at 14-29 kg copper/ha on new muck. Subsequent applications may be made every 2 or 3 years at about 1/3 the rate recommended for new muck.

MANGANESE — Deficient lettuce shows marked yellowing between the veins; the veins themselves remain dark green. Manganese deficiency usually shows up on slightly acid or alkaline muck, peat and dark-coloured sandy soils. Foliar applications, starting after thinning or transplanting, with manganese sulfate at rates supplying 1.0 to 2.0 kg manganese /ha in 3000 L of water, are recommended where manganese deficiency has been a problem. Soil application is not recommended for manganese because of the large amounts required.

DISEASE CONTROL

DAMPING-OFF — Steam or fumigate soil for growing transplants. **(See Damping-Off, page 31.)**

BOTRYTIS — Spray greenhouse-grown seedlings with 76% ferbam WDG 2 kg/1000 L water, or dust with ferbam dust at 1-2 kg/100 m² of bed before first transplanting, and once or twice later at 10-day intervals (spray to wet plants only).

DOWNY MILDEW in coldframes, greenhouses and on late lettuce — Spray every 7 to 10 days with one of:

1. zineb
   Zineb 80 WP 2.25 kg (10 days)
2. maneb
   Maneb 80% WP 2.25 kg (7 days)

SCLEROTINIA (of lettuce, carrots, beans and celery) — Rotate with onions, beets or spinach for 2 to 3 years. Removal of crop refuse will help to control the disease. Use row and plant spacings to encourage good air movement or plant on raised beds.

CORKY ROOT ROT — Allow sufficient time between lettuce crops for the plant residues to decompose completely. Avoid applying excessive amounts of nitrogen, especially urea. Most Boston types have good resistance.

ASTER YELLOWS — See Leafhoppers (Insect Control section).

LETTUCE MOSAIC — Mosaic-indexed or mosaic-tested seed is available from most sources. This seed is produced in special areas where it is carefully checked to ensure that it is virtually free from seed-borne mosaic.

LETTUCE (Continued)

Control aphids, as they spread the disease from infected lettuce plants and weeds such as groundsel, shepherd's purse, and lamb's-quarters.

NEMATODES — **See page 29.**

INSECT CONTROL

ASTER LEAFHOPPERS — Control leafhoppers because they spread aster yellows. Spray lettuce 4 to 5 times at 5- to 7-day intervals, starting when leafhoppers first appear. Leafhoppers must be controlled in older patches by spraying as close to harvest as possible to protect nearby young plantings. Also spray weeds in headlands, ditchbanks, roadsides, etc., and control leafhoppers on adjacent carrots and celery. After harvest, spray unmarketable heads and disk down 24 hours later.

To delay pesticide resistance, alternate the groups of insecticides listed.

Spray with one of:

GROUP A

cypermethrin
Ripcord 400 EC 125 mL (14 days)

GROUP B

1. [3]parathion
   [3]Parathion 15% WP 2.25 kg (7 days head lettuce, 21 days leaf lettuce)
2. malathion
   Malathion 25% WP 4.5 kg (7 days head lettuce, 14 days leaf lettuce)

GROUP C

carbaryl
Sevin XLR Plus 1.25 - 2.5 L (5 days head lettuce, 21 days leaf lettuce)

OR apply phorate (Thimet 15% G) at 7.25 kg/ha in the fertilizer band on one or both sides of the row at seeding time, or when transplants are set in the field. See label for directions and precautions.

OR use disulfoton (Di-Syston 15% G) at 40-75 grams per 100 metres of row at seeding time, in a band on each side of the row. See precautions on the label. Do not use on transplanted lettuce. Use the higher rate on heavy and organic soils.

APHIDS — Apply with one of:

1. dimethoate
   (i) Cygon 480 E 0.7 L (7 days)
   (ii) Cygon 40 EC 0.85 L (7 days)
2. pirimicarb
   Pirimor 50 WP 300-500 g (7 days). (Do not apply Pirimor if lettuce is to be exported to the U.S.A.)
3. disulfoton
   Di-Syston 15% G (see above for leafhopper rates, etc.)
4. malathion
   Malathion 25% WP 4.5 kg (7 days head lettuce, 14 days leaf lettuce)
5. [3]*parathion
   (i) [3]Parathion 15% WP 2.25 kg (5 days head lettuce, 21 days leaf lettuce)
   (ii) [3]Parathion 960 E 350 mL (5 days head lettuce, 21 days leaf lettuce)
6. [2]methamidophos
   [2]Monitor 480 EC 1.1-2.25 L/ha (14 days, do not use on leaf lettuce)

**The green peach aphid may be becoming resistant to this insecticide.*

CABBAGE LOOPER — Spray when loopers first appear with one of:

1. Bacillus thuringiensis
   (i) Dipel WP 1.1 kg (0 days)
   (ii) Thuricide HPC 4.25 L (0 days)
2. [1]methomyl
   [1]Lannate L 2.25-4.5 L (7 days) (Not on leaf lettuce)
3. [2]methamidophos
   [2]Monitor 480 EC 1.25-2.25 L (14 days) (Not on leaf lettuce)

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[1]*Minimum period before reentry is 24 hours.*
[2]*Minimum period before reentry is 48 hours.*
[3]*Minimum period before reentry is 7 days.*

ONION

CULTIVARS
(Revised for 1990)

	Early	3 to 14 days later, in order of maturity
COOKING* (seeded)	Eskimo Norstar Rocket Columbia Hustler (*trial*)	Tarmagon Trapp's No. 6 Taurus Aries Nutmeg Trapp's No. 8 Buccaneer Improved Paragon Canada Maple Autumn Keeper Sweet Sandwich Russet Copra Sentinel Flame (*trial*)
SETS		BUNCHING
Ebenezer (White and Yellow) White Portugal Stuttgarter		Japanese Bunching Southport White Globe White Knight
PICKLING		TRANSPLANTS
Pompei Barletta Silver Queen White Portugal	pearl type	Sweet Spanish types (open-pollinated) *For muck soils* Brahma Cima Sierra Fiesta Matador Bullring
RED (in order of maturity) Ruby Southport Red Globe (*trial*) Red Wethersfield (*trial*) Benny's Red Carmen (*trial*)		

*See Cultivar Descriptions for suitability for storage.

CULTIVAR DESCRIPTIONS

Aries — Good yield and quality, suitable for storage.

Autumn Keeper — Very firm, medium-sized, globe-shaped bulbs suitable for long-term storage.

Barletta — Used for pearl-onion processing.

Benny's Red — Red-skinned, attractive, matures about 2 weeks later than Autumn Spice, not for long storage.

Brahma — Large-bulbing, mid-season maturing Spanish type, good resistance to bolting, high yield potential, good quality, light brown skin.

Buccaneer Improved — Very firm, globe shaped, excellent for long-term storage, high yielding.

Bullring — Sweet Spanish type, high percentage of single centres, excellent quality, large bulb, mid-season maturity.

Canada Maple — Bulbs very firm, medium to large, round, high yield, suitable for long-term storage.

Carmen — Red-skinned, late maturing, globe-shaped, firm, high-scoring hybrid, suitable for storage.

Cima — High yield potential, high quality, Spanish jumbo type, good resistance to premature bolting, globe shaped, light brown skin, mid-late season maturing.

Columbia — Early maturing, very good yield, firm, suitable for storage.

Copra — Very firm, very late maturity, high yielding, excellent scoring, excellent for long-term storage.

Ebenezer — (White or Yellow) — White Ebenezer is used for very early, mild, green bunching onions. Yellow Ebenezer is a set-onion type for the production of cooking onions.

Eskimo — Very early maturing, good neck finish, medium-size bulbs, suitable for short-term storage only.

Fiesta — Mid-season maturing, shallow globe, brownish-yellow bulbs, resistant to bolting, good quality, Sweet Spanish hybrid.

Flame (*trial*) — Very late maturing, high yield potential, large bulb size, mid-season storage.

Hustler (*trial*) — Early maturing, good bulb size, mid-season storage.

Japanese Bunching — A non-bulb-forming, overwintering type, usually strong and pungent flavour.

Matador — Mid- to late-season-maturing Sweet Spanish of high quality, good resistance to bolting.

Norstar — Very early maturing, large size, high yield potential, for short-term storage only.

Nutmeg — Early maturing, medium-sized bulbs, globe shaped, good colour, medium to high yield, long-term storage.

Paragon — Very firm, high yield potential, good bulb size, excellent quality, suitable for long-term storage.

Pompei — White, earlier than Barletta, used for pearl-onion processing.

Red Wethersfield — Red skinned, firm, medium yielding, flat, good scoring, not suitable for long storage.

Rocket — High yield, somewhat lighter colour and not quite so firm as Autumn Spice, suitable for long-term storage.

Ruby — Red-skinned, attractive, matures about 2 weeks later than Autumn Spice, short storage only.

Russet — Very high yield potential, very late maturing in Bradford area, fairly firm.

Sentinel — Very late maturing in Bradford area, very firm, excellent quality, very good yield potential, excellent for long storage.

Sierra — Large, deep, globe-shaped bulbs, maturing mid-season, brown skins, high quality, very good resistance to bolting. Sweet Spanish hybrid type.

Silver Queen — Used for pearl-onion processing.

ONION (Continued)

Southport Red Globe — Red-skinned, relatively early maturing, fairly firm, medium yielding, good quality, suitable for short storage.

Southport White Globe — The main green bunching onion for early, mid-, and late season.

Stuttgarter — Set-onion type used for set production, prefers sandy loam.

Sweet Sandwich — Very high yielding, top shaped, very uniform size and shape, good colour, relatively mild after some weeks in storage, suitable for medium-long storage.

Tarmagon — Early maturing, very high yield potential, large globe size, quite firm, suitable for medium-long storage.

Taurus — Medium to early maturing, medium-large globe, good yielding, suitable for storage.

Trapp's No 6 — High yield, globe shaped, good colour, firm, suitable for long-term storage.

Trapp's No. 8 — Very firm, good yielding, globe-shaped, high scoring, uniform, excellent colour, long storage.

White Knight — A relatively new, long, white, green bunching type.

White Portugal — Used for green bunching, and for pickling.

SEEDING AND SPACING

Dry onions:	4 to 4.5 kg/ha
Bunching onions:	up to 7 kg/ha
Pickling onions:	35 to 45 kg/ha
Sets:	70 to 80 kg/ha

SPACING — Rows 35-43 cm apart or 15 and 60 cm apart alternately, with 20-40 plants per metre of row for dry onions and 10 cm apart in the row of Spanish transplants.

IRRIGATION

Onions have a shallow and limited root system, and should be irrigated frequently throughout the growing season. The soil moisture should not be permitted to fall below 50%. The plants should receive 2.5 cm of water a week, either as rainfall or irrigation. Irrigation may not be necessary on deep muck soils. Maintain the water table at 85 cm below the soil surface on muck soils.

FERTILIZER

SOIL TESTS are required to determine phosphate and potash requirements. **(See tables on pages 26 and 27.)**

NITROGEN — On MINERAL SOIL and on MUCK SOIL apply up to 120 kg/ha; 90 kg/ha applied preplant with one side-dressing of 30 kg N/ha when plants are 8-10 cm high (if rainfall has been above normal and soil temperatures below normal). If manure is applied or legume sod is plowed down, reduce the nitrogen application. **(See tables on pages 16 and 18.)**

APPLICATION — Apply 2/3 of the nitrogen before planting and the remainder side-dressed after the onions are about 15 cm tall.

MICRONUTRIENTS — COPPER deficiency occurs on acid, peat and muck soils. Onion bulbs show poor-coloured skins. Copper may be mixed with the fertilizer and applied at 14-29 kg copper/ha on new muck. Subsequent applications may be made every 2 or 3 years at about 1/3 the rate recommended for new muck.

MANGANESE deficiency shows up as a yellowing between the leaf vein. Foliar applications of manganese sulfate are recommended, starting when the plants are about 15 cm tall, with 1.5-2.75 kg manganese/ha in 300 L water and repeated in 4 to 5 sprays 10 days apart. Use the low rate on small plants, increasing the rate as the season progresses. Soil application is not recommended for manganese because of the large amounts required.

MOLYBDENUM deficiency may occur when onions are grown on moderately acid to strongly acid muck soils. A seed treatment has proven beneficial. The treatment is accomplished by dissolving 15 grams of sodium molybdate in 45 mL of water. Spray this solution from an atomizer bottle on 2.3 kg seed spread thinly on a plastic sheet. Do not use excessive water, as this can cause the chemical to penetrate the seed embryo and cause injury. Mix the seed thoroughly and let dry.

Spraying plants with sodium molybdate at rates supplying 60 g of molybdenum in 300 L of water will also help to avoid deficiency symptoms.

ZINC deficiency in onions shows up as a stunting and marked twisting and bending of yellow-striped foliage. It occurs mainly with shallow muck soils or where the calcareous subsoils are mixed with the muck during a tile-drainage operation.

If zinc deficiency is a problem, spray the foliage with zinc sulfate at rates supplying 0.6 kg zinc per 1000 L water.

DISEASE CONTROL

DAMPING-OFF AND ROOT ROT — For Spanish onion transplants, treat seed with thiram seed protectant. Use pasteurized soil or soilless mix and disinfect trays. For field-sown onions, treat seed with thiram.

DOWNY MILDEW, BOTRYTIS LEAF SPOT AND PURPLE BLOTCH — Plant sets and mother bulbs as far as possible from onions being grown from seed. These diseases develop in humid weather or when rains and heavy dews occur frequently. Begin spraying when these conditions occur after early June in southwestern Ontario and after mid-June in the Bradford area. Then spray every 7 to 10 days with one of the following fungicides; a spreader-sticker may be required if recommended by the manufacturer.

Note: Botrytis leaf blight and downy mildew are monitored in the Bradford, Port Colborne and Thedford-Grand Bend marsh areas. Consult your local Pest Management Advisor for up-to-date information on disease development and timing of sprays.

1. zineb
   Zineb 80 WP 2.25 kg (7 days)
2. maneb
   Maneb 80% WP 2.25 kg (10 days)
3. mancozeb
   (i) Mancozeb 80% WP 2.25-3.25 kg (10 days)
   (ii) Dithane M-45 2.25-3.25 kg (10 days)
   (iii) Manzate 200 2.25-3.25 kg (10 days)

ONION (Continued)

4. anilazine
   Dyrene 50% WP 2.25 kg (7 days)
5. captafol
   Difolatan 480 F 5.5 L (1 day)
6. iprodione
   Rovral 0.75 kg (15 days) (when tank mixed with label rates of maneb or mancozeb)

Note: Rovral when tank mixed will control Botrytis, leaf blight and downy mildew when applied on a preventative basis. This tank-mix combination will help reduce the chance of resistance to iprodione.

SMUT — Use one of:

1. Thiram-insecticide combination (granules) — Apply at seeding time at a rate that supplies 2.25-3.25 kg (active ingredient) thiram per hectare; and add thiram 75% WP to the seed at 250 g for each kg of seed. See Onion Maggot furrow granular treatment.
2. Treat seed with carbathiin + thiram (PRO-GRO) 60 grams to 2.3 kg of seed. Thorough mixing of PRO-GRO with the sticker and the seed is essential for good control. Mix until no uncoated seeds can be found. Read label directions. See Onion Maggot.
3. 37% formaldehyde — Add 1.25 L to 100 L of water and apply the diluted formaldehyde, while seeding, at 1000 L per hectare (rows 40 cm apart), or 4.5 L to 100 metres of row.
4. Steam soil for growing Spanish onion transplants.

BOTRYTIS NECK ROT AND SMUDGE — Be certain onions are mature before harvesting. Cure and dry onions properly. Artificial heat may be beneficial. Store under cool, dry conditions. White and Spanish-type onions are more susceptible to these diseases.

WHITE ROT — This disease is present in Holland, Thedford, Grand Bend and Point Pelee marshes. The fungus survives as sclerotia in the soil for long periods. The hosts are within the onion family: onion, shallot, leek, garlic. Long-term rotation with carrots, lettuce, potatoes or other crops not related to the onion family is recommended.

Sanitation is extremely important in preventing the spread of this disease. Wash down machinery after it has been used in an infested field. Avoid cultivation practices that can spread contaminated soil from one area to the rest of the field. Dispose of cull onions in a sanitary landfill or bury away from areas of onion production. Pallet boxes that have been used to hold contaminated soil or diseased onions may also be a source of disease. Botran may be helpful for control in the field. Follow manufacturer's directions. Flooding the field for 3 weeks in the fall or spring has been effective in reducing the overwintering sclerotia of the fungus.

BACTERIAL DISEASES — There are at least three different diseases of onions caused by bacteria; these are soft rot, slippery skin and sour skin. The bacteria which cause slippery skin and sour skin can enter the onion through wounds on the leaves, and when heavy irrigation or rainfall results in water standing in the leaf axils and neck. Any of these bacteria can enter the bulb when the leaves wither after windrowing or through injuries that occur at harvest. Soft rot often occurs when bulbs are damaged by the onion maggot or by other bulb diseases. To reduce bacterial diseases, control the onion maggot, do not over-irrigate and avoid damaging the onions at harvest. Let the onions mature properly before harvest, then cure and dry them rapidly.

NEMATODES — See page 29.

INSECT CONTROL

ONION MAGGOT

1. **Dry onions grown from seed** — Apply soil treatment as in (a) and spray for onion maggot flies as in (b)

a. **Furrow granular treatment:** Apply granular formulation in furrow with seed. See Smut. Amounts given are for one hectare. These dosages are based on single-row seeding spaced 40 cm apart. Growers should adjust the dosage if row spacing or planting methods differ.

Apply one of:

1. 5% Dyfonate — 10% thiram combination, 22.5 kg (Do not use on mineral soils.)
2. chlorpyrifos (Lorsban 15 G) 8-16 kg, **only with carbathiin + thiram-treated seed.** Use only on dry onions and pickling onions.

*3. 5% ethion-7.5% thiram combination, 35-45 kg.

*4. carbofuran (Furadan) 10G, 17 kg, **only with carbathiin + thiram-treated seed.** Do not use on pickling onions, green bunching onions, onions grown from sets, or Spanish onions from transplants.

**Resistance to these insecticides has been observed in Ontario muck soils.*

OR

b. **Sprays for onion maggot flies. Proper placement of granular insecticides at the correct rate is the key to onion maggot control.** If difficulties are encountered with the granular application, sprays to kill the flies may reduce damage. Spray with one of the following materials in sufficient water to obtain good coverage as soon as flies appear. Repeat at 7- to 10-day intervals. To limit the development of resistance, the insecticide from Group A must be used alternately with insecticides from Group B.

Group A

1. cypermethrin
   (i) Ripcord 400 EC 175 mL (3 days)
   (ii) Cymbush 250 EC 280 mL (3 days)

Group B

1. diazinon
   (i) Diazinon 50% WP 1.0 kg (10 days)
   (ii) Diazinon 500 EC 1.5 L (10 days)
   (iii) Basudin 50 EC 1.1 L (10 days)
2. [3]parathion
   [3]Parathion 15% WP 2.25 kg (15 days)
3. naled
   Dibrom 8.64 EC 550 mL (4 days)
4. malathion
   Malathion 500 EC 2.75 L (3 days)

ONION (Continued)

In some areas monitoring programs are carried out for the onion maggot and treatments can be timed to coincide with peak activity of the adults. This may reduce the number of spray applications. Consult your Pest Management Advisor for timing.

Note: Permethrin 500 EC 280 mL (3 days) used for cutworm control on seedling onions will provide some control of onion flies **(see page 30).** This product also belongs in Group A, and the same considerations about alternating insecticides apply.

2. **Other Onions**
   a. Dutch Sets — Make sure insecticide is distributed evenly over the entire width of the row. Apply soil insecticide treatment as in 1(a) and sprays as in 1(b).
   b. Pickling Onions from Seed — Apply fonofos or ethion or chlorpyrifos as in 1(a) (for muck soils only) and sprays as in 1(b).
   c. Green Bunching Onions from Seed — Apply ethion as in 1(a) and sprays as in 1(b).
   d. Green Bunching Onions from Sets — Apply sprays as in 1(b).
   e. Spanish Onions from Transplants — Special application equipment is required to distribute insecticide uniformly within the furrow. Apply soil insecticide treatment as in 1(a) and sprays as in 1(b).
   f. Cooking Onions from Sets — Apply sprays as in 1(b).

Onions left in the field after harvest are a major source of overwintering onion maggot. This is especially true following early harvest of Dutch sets and pickling onions. Prevent all regrowth. Remove where possible, or plow under immediately after harvest.

THRIPS — cypermethrin and [3]Parathion, as recommended for onion maggot flies, also controls thrips.
Consult **OMAF Factsheet, Thrips on Onions and Cabbage, Agdex 250/612.**

[3]*Minimum period before reentry is 7 days.*

SPROUT INHIBITION

The use of maleic hydrazide (Royal MH 60) sprays will improve the storage life and quality of onions by inhibiting sprouting in storage. Short storage-life cultivars do not benefit from maleic hydrazide sprays. Apply at a rate of 3.75 kg in a minimum of 300 L of water/ha for ground equipment or a minimum of 100 L of water for aerial equipment. To obtain maximum benefit, spray when about 50% of the onion tops have fallen and each plant has 5-8 green leaves. This will occur about 10-14 days before harvest. Earlier application may result in spongy, hollow-necked bulbs.

PARSNIP

For more details, **consult OMAF Factsheet, Commercial Parsnip Production in Ontario, Agdex 258/13.**

CULTIVARS

(Revised for 1990)

Hollow Crown Improved	Model	All-American

SEEDING AND SPACING

Parsnips are a long-season crop (100 to 130 days to maturity), so the seed must be sown as early as possible. Always use seed produced the preceding year. The seed is slow to germinate, especially in dry, cool soils. Poor stands occur if the soil surface becomes baked or crusted before the seedlings emerge.

RATE — 3 to 5.5 kg per hectare

DEPTH — 6 to 20 mm

ROW SPACING — 45 to 75 cm, depending on machinery used in cultivation.

THINNING — Thin seedlings 3-6 cm in the row. On muck soils seeders should be adjusted to ensure a stand of 16 to 33 plants per metre of row.

SOIL

Parsnips require deep, loose, fertile soils, preferably a well-drained, warm sandy loam. Well-drained muck soils are also suitable. The desired pH is about 6.5.

FERTILIZER

Fertilizer requirements are the same as for carrots.

DISEASE CONTROL

ITERSONILIA CANKER AND LEAF SPOT — High ridging to cover the shoulder of the roots is helpful.

PHOMA CANKER AND LEAF SPOT — Hollow Crown Improved and All-American are tolerant cultivars. They can be grown instead of Model, the most susceptible cultivar, and harvested before maximum root and shoulder development. Rotate with other crops. Removal of crop refuse will help control the disease. Handling diseased or healthy plants using gloves will prevent the development of severe skin rashes for some people.
For more details, **consult OMAF Factsheet, Phoma Canker of Parsnip, Adgex 258/635.**

ROOT-KNOT NEMATODES — **See page 29.**

PEA

For more details, consult **OMAF Factsheet, Peas for Processing, Agdex 255/20.**

CULTIVARS

(Not revised for 1990)

MARKET	PROCESSING
Sugar-Snap types Green Arrow Little Marvel Alderman (Tall Telephone) Progress types Lincoln (Homesteader)	As recommended by processors

SEEDING

DATE — As early as possible. Sowing of acreage for processing is now scheduled on the basis of accumulated heat units.

RATE — 250 to 400 kg/ha, depending on seed size and percent germination.

DEPTH — During April and early May soil moisture is usually adequate and seed can be sown 2.5 to 4 cm deep. For later seedings a depth of 4 to 5 cm may be necessary.

FERTILIZER

SOIL TESTS are required to determine phosphate and potash requirements. **(See tables on pages 26 and 27.)**

NITROGEN — 15 kg N/ha is recommended at seeding where phosphate and potash are required. If no phosphate and potash are required, the nitrogen may be omitted.

APPLICATION — Fertilizers should be broadcast and worked in before seeding. Do not drill fertilizer with the seed.

DISEASE CONTROL

ROOT ROT, WILT AND NEAR-WILT — Follow a 4-year rotation and other good management practices such as:

1. Select and plant only well-drained fields.
2. Minimize soil compaction.
3. Work fields immediately after harvest.
4. Plan a green-manure crop such as sorghum, Sudan grass, or fall rye.

INSECT CONTROL

SEED MAGGOTS, WIREWORMS AND SEED DECAY — Treat seed with diazinon, lindane, and a fungicide. See **Chemical Seed Treatment, page 31.**

PEA APHID — This aphid is usually more abundant when peas are grown adjacent to clover or alfalfa. Various methods of sampling are carried out by fieldmen to tell whether sprays are required.

1. dimethoate
   Cygon 480 E 425 mL (3 days). Do not feed or graze vines within 21 days of last application.
2. malathion
   (i) Malathion 25% WP 4.5 kg (3 days)
   (ii) Malathion 500 EC 1.75 L (3 days)
3. [3]parathion
   [3]Parathion 800 EC 275-525 mL (10 days). Do not feed or graze within 15 days of last application.
4. pirimicarb
   Pirimor 50 W 150-275 g (6 days)

PEA WEEVIL — Infested seed should be fumigated. Use a commercial grain fumigant.

[3]*Minimum period before reentry is 7 days.*

Handy Metric Conversion Factor

Litres per hectare x 0.4 = litres per acre
Kilograms per hectare x 0.4 = kilograms per acre

PEPPER

CULTIVARS
(Revised for 1990)

SWEET

EARLY	*LATE*
Vinedale	Bell Boy (hybrid)
Sweet Hungarian (Yellow Banana)	California Wonder
Super Set 19 (hybrid)	Emerald Giant
Super Shepherd	Greenboy (hybrid)
	Gedeon (hybrid)
	Keystone Resistant Giant
MID-SEASON	Midway
Early Niagara	MA 79252 (hybrid)
Golden Bell	Yolo Wonder 43
Lady Bell (hybrid)	
Staddon's Select	
Jupiter (*trial*)	
Bell Captain (hybrid)	
Belle Star (hybrid)	

HOT

Crimson Hot	Long Thick Red
Hungarian Wax	Romanian Wax

CULTIVAR DESCRIPTIONS

Bell Boy — Thick-walled, medium-large, blocky fruit, good uniformity; high yields; large plant.

Bell Captain — Large fruit, 4-lobed slightly elongated bell, medium-size plant with good foliage cover, good mid-season producer.

Belle Star — Thick-walled, 4-lobed blocky bell, plants medium size with good foliage cover, early to mid-season.

California Wonder — Standard cultivar, large vigorous plants, large, blocky, dark green fruits.

Crimson Hot — Hot pickling/fresh Chili-type, 14 cm long and 3.5-4.5 cm at the shoulder, fruit turns dark red and sits high on a fairly large plant.

Early Niagara Giant — Large fruits with few locules, somewhat late, especially recommended for southern areas.

Emerald Giant — Very thick-walled, attractive, uniform, medium-large, bell-type fruit; productive; mid-late season; plants large.

Gedeon — Heavy, smooth, 4-lobed, very large bell-type fruit; plants large with good fruit cover.

Greenboy — Thick-walled, attractive, fairly heavy bell type; excellent yields on medium-large plants, particularly late in season.

Golden Bell — Bright orange, attractive, heavy sweet bell type; reliable producer.

Jupiter — Thick-walled, blocky, smooth fruit on medium-large plants with good foliage cover. Good producer in mid-early season.

Hungarian Wax — Hot pickling type, prolific, 12 to 15 cm long, yellow fruits turn to crimson when mature.

Keystone Resistant Giant — Heavy-walled, medium-sized, blocky, bell-type fruit; plants medium size; most productive in southwestern Ontario.

Lady Bell — Fairly thick-walled, 3- to 4-lobed bell type; flat plant; dependable producer.

Long Thick Red — Hot, approximately 15 cm long, dark green shiny fruits, turning early to brilliant red when mature.

Midway — Large, smooth, attractive, uniform, blocky fruits, relatively small plants.

MA 79252 — Large upright plant with good foliage cover; 3- to 4-lobed, blocky, thick-walled, large fruit; mid-late season.

Romanian Wax — Hot pickling type with upright, semi-long, pointed fruits.

Staddon's Select — Good producer, especially in the southern areas; fruits are smooth, large, dark green.

Super Set 19 — Heavy set of medium-size, bell-shaped, thick-walled fruit on medium-sized plants, early in southwestern Ontario.

Super Shepherd — Early, productive, with 15 to 18 cm pointed pendant fruit with thick walls.

Sweet Hungarian (Yellow Banana) — Long, slender fruits with a diameter of 4 to 5 cm at the shoulder gradually tapering to a point, light cream in colour.

Vinedale — Fruits dark green with thick walls, medium size, smooth-pointed pimento shape, especially suggested for Niagara Peninsula.

Yolo Wonder 43 — Long bell type, slightly tapering, dark green fruits often with only 2 locules.

SEED TREATMENT

Sow hot-water treated seed (see page 31). Before sowing, dust seed with thiram seed protectant.

SEEDING AND SPACING

Two hundred grams of seed should produce enough plants for a hectare.

Rows 90 to 120 cm apart. Plants 35 to 45 cm apart.

GROWING THE PLANTS

Because peppers require a long growing season, they are started in a greenhouse or hotbed. The seed is sown in shallow flats of soil 9 to 10 weeks before field transplanting because the seed germinates slowly. A temperature of 27 to 29°C is required for good seed germination and steady plant growth.

When the first true leaves are about 1.5 cm long, transplant the seedlings to other flats containing a fertile compost soil. Space the plants 5 to 7 cm apart. Where space is available, transplanting to 8- to 10-cm plant containers will produce larger plants with compact, well-developed root systems. These plants suffer less from transplanting shock.

PEPPER (Continued)

Alternatively, plants can be raised by seeding raw or pre-germinated seed directly into peat pots, multi-pot trays, wedge-shaped plant modules such as seedling flats, or directly into beds filled with special growing media. Such a system is less labour intensive, results in superior plant material raised in a shorter time and reduces transplanting shock.

Pepper plants are hardened for about one week before transplanting to the field by reducing the soil moisture supply and maintaining a temperature of 13 to 16°C. Hardening of pepper plants gives resistance to wilting, but not to frost.

COLD TREATMENT

The number of flowers and fruits on the plants can be increased by exposing the seedlings to a controlled cold treatment, as follows:

1. Germinate seed at 27 to 29°C in flats of pasteurized soil or sterile soilless mix.
2. When the third true leaf of the seedlings appears, grow the plants at a minimum night temperature range of 12 to 13°C for 4 weeks. The plants can receive the cold treatment either before or after the first transplanting. The plants should receive as much sunlight as possible.
3. After 4 weeks of cold treatment, grow the plants at the recommended temperature of 21°C.

FERTILIZER

SOIL TESTS are required to determine phosphate and potash requirements. **(See tables on pages 26 and 27.)**

NITROGEN — Apply up to 70 kg N/ha. If manure is applied or legume sod is plowed down, reduce the nitrogen application. **(See tables on pages 16 and 18.)**

APPLICATION — Broadcast 35 kg N/ha and all of the phosphate and potash required before planting and work in. The remainder of the N should be side-dressed after first fruit set, if required.

STARTER SOLUTION — At transplanting apply a starter solution high in phosphorus such as 1 L of 10-34-0 per 100 L of water or 1 L of 6-24-6 per 75 L of water. Under high temperature conditions or in dry, sandy soils reduce the amount of fertilizer by one-half but continue to use the same volume of water. This will reduce the risk of crop injury under these growing conditions.

DISEASE CONTROL

DAMPING-OFF — See Seed Treatment and sections on Hot-Water Seed Treatment and Damping-Off of Seedlings **(page 31)**. Because unsterilized soil and mixes containing peat moss, pit sand and soil often give rise to damping-off, sow and transplant only in a sterilized medium. Drench flats at time of first watering with captan 50% WP or 80% WP (see label). Spray when first true leaves develop with captan 50% WP 2.25 kg and repeat every 7 to 10 days. Apply sufficient spray to wet plants and run down stems.

BACTERIAL LEAF SPOT — See IN THE SEEDBED in the Disease Control section of Tomato, page 75. It is not possible to completely control this disease with chemical sprays. A reduction in the number of lesions may be achieved through the application of a copper bactericide tank mixed with mancozeb 80 WP at 2.25 kg product per hectare. Do not delay spraying these compounds once mixed in the tank. In periods of extended wet weather, a control using copper materials may not be satisfactory.

VIRUS — Control aphids (see Insect Control). Some cultivars have considerable resistance to some viruses. (Consult seed catalogue.)

VERTICILLIUM WILT — Grow seedlings in sterilized soil. Wilt may be serious following peppers, tomatoes, eggplant, potatoes, strawberries and raspberries.

NEMATODES — **See page 29.**

INSECT CONTROL

APHIDS — Spray with one of the following, which are listed in order of best control:

1. pirimicarb
   Pirimor 50 W 275-550 g (3 days)
2. dimethoate
   Cygon 480 E 0.7-1.0 L (3 days)
3. diazinon
   Diazinon 50% WP 1 kg (5 days)
4. endosulfan
   (i) Thiodan 50% WP 1.1 kg (2 days)
   (ii) Thiodan 4 EC 1.4 L (2 days)
   (iii) Endosulfan 400 EC 1.5 L (2 days)

TARNISHED PLANT BUGS — Dimethoate, as recommended for aphids, will give some control of tarnished plant bugs.

CORN BORER — Peppers are susceptible to corn borer attack when the fruit are the size of walnuts and must be protected until harvest if corn borers are present. A European corn borer monitoring service now provides information on adult flight patterns throughout Ontario. Consult Agriphone for details. For chemical control, thorough distribution of spray material is required. If a hydraulic boom sprayer is used, solid- or hollow-cone nozzles on drop pipes have improved coverage. Add an insecticide for aphids when needed. Carbofuran also suppresses aphids.

Use one of:

1. deltamethrin
   Decis 2.5 EC 600-700 mL (3 days)
2. permethrin
   Ambush 500 EC 140 mL (1 day)
3. [2]carbofuran
   [2]Furadan 480 F 1.1 L (3 days) Do not use more than 6 applications per season.
4. carbaryl*
   Sevin XLR Plus 2.5-5.25 L (2 days)

**In areas where corn borer has been a severe problem, spray every 4 days.*

PEPPER (Continued)

PEPPER MAGGOT — In areas where required, apply 4 sprays at 7-day intervals starting the last week of June or first week of July using one of:

1. endosulfan
   (i) Thiodan 50% WP 1.1 kg (2 days)
   (ii) Thiodan 4 EC 1.4 L (2 days)
   (iii) Endosulfan 400 EC 1.5 L (2 days)
2. malathion
   Malathion 25% WP 5.5 kg (3 days)
3. dimethoate
   Cygon 480 E 0.7-1.0 L (3 days)

[1] *Minimum period before reentry is 48 hours.*

POTATO

For more details, consult OMAF Publication 534, Potato Production in Ontario. For detailed information on cultivars, consult the OMAF Management Profile Factsheets. Seed availability of new or specialty cultivars can often be limited. To ensure a supply of seed, growers should contract with their seed growers. For information on contracting and seed availability lists, contact the Ontario Seed Potato Growers Association at P.O. Box 370, Alliston, Ontario L0M 1A0.

CULTIVAR DESCRIPTIONS

Listed in order of maturity
(See Table Below For Recommended Market Use)

Jemseg — Very early; smooth, blocky tubers; good yield; early-season boiler and chips out of the field; tubers oversize very quickly; tubers allowed to oversize usually develop hollow heart; not a storage potato; immune to virus X; resistant to viruses Y and S; moderately resistant to common scab; susceptible to leafroll, Verticillium wilt and Fusarium storage rot; cut seed should be held and suberized before planting. Due to poor eye distribution, large seed tubers (over 250 g) are best cut by hand to avoid poor stands from blind seed pieces.

Eramosa — Very early, smooth, round, flattish tubers; sets and sizes evenly; vines are very determinate, sets very few flowers; tuber skin is attractive; moderately susceptible to scab and virus Y; not prone to oversizing and has some field tolerance to leaf-roll; seed should be well warmed or chitted prior to planting.

Superior — Early; fairly smooth; high yield; good for tablestock and as a midsummer chipper; stress (e.g., drought or disease) reduces yields substantially; resistant to scab but very susceptible to Verticillium wilt at maturity; may be subject to seed-piece breakdown in a wet spring.

Conestoga — Early; blocky, medium-smooth; very vigorous early growth; yield comparable to Superior; good boiler, chips well out of the field; moderately resistant to leafroll, early blight and common scab; moderately susceptible to mild and rugose mosaic.

Redgold — Medium-early; round rose-skinned tubers with deep yellow flesh; sets heavily and may fail to size well and has only average dry matter but good flavour. Will sprout readily after harvest where most cultivars require several weeks to break dormancy. Susceptible to ozone injury. A specialty potato for the "technicolour trade".

Yukon Gold — Medium-early; tubers round, smooth; yellow-fleshed with pink eyes; good flavour; medium-high yield; good boiling, baking and French-fry quality; chips out of the field; upright plants; moderately susceptible to common and pitted scab and virus Y and ozone; resistant to mild mosaic and leafroll; excellent keeping potato; often sold in stores by name; cut seed is best held to suberize before planting to avoid poor stands.

Atlantic — Medium-early; round, smooth; medium-netted tubers; high yield and dry matter, vigorous plant; chips excellent out of the field; but chip colour is variable out of 10°C storage; tolerant to Verticillium wilt; resistant to virus X, pink eye, but susceptible to internal heat necrosis in hot soils, Fusarium dry rot in storage and hollow heart, white knot and postemergent applications of metribuzin. Moderately susceptible to metribuzin applied preemergent on low organic-matter soils; susceptible to harvest bruising and pressure bruising in storage.

Cherokee — Medium-early, medium yield potential and good keeper in storage. Tubers have one of the whitest skins of any variety and are very attractive for the washed trade. Mis-shapen tubers may be a problem under adverse weather conditions; resistant to common scab and some races of late blight; susceptible to Verticillium wilt and leafroll.

Keswick — Mid-season; light green foliage; fairly smooth under close spacing; good cooking quality; makes good mid-season French fries; resistant to scab, late blight and hollow heart; susceptible to virus Y, Fusarium dry rot and mosaic; better adapted to northern Ontario.

Norchip — Mid-season; roundish, white-skinned, slightly rough tubers; sets a lot of tubers so needs 30 to 33 cm spacing for better sizing; medium yield; responds to higher nitrogen, scheduled irrigation and strong soil with good tilth; good chipper out of 10°C storage; resistant to scab and hollow heart; susceptible to early and late blight, Verticillium wilt or any setback in growth.

Saginaw Gold — Maincrop with attractive skin and light yellow flesh; good yield, good flavour and nice vine; bred at Michigan State University and entirely developed in Ontario . . . the first "Free Trade" potato! Chips very well out of 10°C storage and has field resistance to disease pick-up; only medium scab resistance.

POTATO (Continued)

Monona — Maincrop; roundish, white-skinned, medium eyed tubers, medium to good yield; sizes better than Norchip but is low in dry matter; chiefly used as a long-term 10°C storage chipper; not recommended for tablestock; resistant to virus Y, A, and Verticillium wilt; moderately susceptible to hollow heart and blackleg; requires good storage ventilation.

Chieftain — Maincrop; fairly smooth, round; red skin, very white-fleshed tubers, sets heavily; high yield; low dry matter; good boiler but doesn't process; susceptible to Verticillium wilt, blackleg, virus X and Y; moderately resistant to common scab, Rhizoctonia, stem-end browning and late blight; skin must be mature to avoid feathering at harvest; susceptible to shattering under wet soil conditions coupled with wide differences in air and ground temperature; more susceptible to heat necrosis than Rideau.

Kennebec — Maincrop; heavy, vigorous plant; tubers thin-skinned, set light and size well; plant under close spacing 20-25 cm; very high yield and medium dry matter and good flavour; do not use more than 130 kg of nitrogen; chips but does not store reliably in 10°C storage; fair French-fry quality; tubers green rapidly under light; resistant to virus A and Y and visual field mosaic, foliage late blight, and drought; very susceptible to Verticillium wilt and pink eye; moderately susceptible to common scab, late blight tuber-rot and leafroll.

Shepody — Maincrop; large, oblong, smooth-eyed tuber; good to high yield; excellent boiler, baker and French-frier, good pre-peeler; does not chip out of storage; medium dry matter; moderate resistance to early blight, Fusarium dry rot and Rhizoctonia; moderately susceptible to common scab, Verticillium wilt, late blight and virus Y and S; very susceptible to mild mosaic and postemergent applications of the herbicide metribuzin. Preemergent applications of metribuzin on low organic-matter soils may also cause damage; good resistance to tuber shattering.

Rideau — Late maincrop; high yielding, slightly oblong, large, round tubers; very shallow-eyed with a bright red skin and very white flesh; persistent vine; low to medium dry matter; good flavour; good boiler, does not process; resistant to Verticillium wilt, moderately resistant to scab and mosaic; susceptible to Rhizoctonia; has done well in light, sandy soil.

Sebago — Late; good cooking quality and flavour; yield variable; round shallow-eyed, white-skinned tuber; moderately resistant to virus A, Y, X, common scab and blight; sprouts early; very susceptible to blackleg.

Main End Uses For Potatoes Grown In Ontario

TABLESTOCK	PROCESSING
Superior (main early)	Norchip (main storage chipper)
Shepody (main storage)	Atlantic (main field chipper)
Kennebec (storage)	Monona (long storage chipper)
Chieftain (main red)	Superior (field chip - prepeel)
Sebago (storage)	Shepody (prepeel)
Yukon Gold (yellow flesh)	Kennebec (prepeel chip)
Jemseg (earliest)	Conestoga (field chipper)
Conestoga (early, table)	Saginaw Gold (new)
NEW OR SPECIALTY	
Jemseg (very early)	Red Gold (red skin, yellow flesh)
Eramosa (very early)	Saginaw Gold (light yellow flesh)
Rideau (red skin)	Keswick (French fry for North)

SANITATION

The storage and all potato equipment including cutting knives and containers should be completely cleaned before using. Clean out and thoroughly scrub with detergent all machinery, equipment, walls, floors, etc., and then use a quaternary ammonium compound labeled for bacterial ring rot control as a disinfectant. All cull potatoes should be spread out on the field to freeze, or destroy all potato foliage on cull piles early in the season with a suitable vine killer.

SEED HANDLING AND TREATMENT

Plant Foundation or Certified seed to reduce loss from leafroll and other viruses, bacterial ring rot, Verticillium wilt, Rhizoctonia, and common scab.

Inspect seed on arrival and during cutting. Discard tubers and seed pieces showing rot.

Where practical, warm seed potatoes before cutting at 18 to 20°C for 2 weeks in good light. Cut seed not being planted immediately should be given special attention to ensure healing and suberization by:

(a) Forced-air circulation through the shallow pile.
(b) Temperatures of 10 to 15°C.
(c) High relative humidity in the air of 90 to 95%.
(d) Maintain these conditions for 3 to 4 days.
(e) After this, temperature may be lowered but maintain humidity and run fans intermittently.

Cut seed stored in boxes or bags should receive the same treatment and be piled to allow good air movement around each container.

Never allow cut seed to stand in the hot sun or in drying wind. This causes minute cracks in the skin that allow bacteria and fungi to become established.

Do not plant in hot, dry soil or in cold, wet soil.

Do not plant potatoes immediately after plowing down a heavy stand of rye.

Chemical Treatment — Seed-piece treatments with a commercial dust may be beneficial, particularly in areas where maggots are a serious pest. The following commercial dusts may be used (rates are for 50 kg of cut seed):

1. metiram-diazinon dust at 450-700 g
2. captan 7%-diazinon 0.1% dust at 450 g
3. thiophanate-methyl (Easout) Potato Seed-Piece Treatment at 250 g
4. metiram 7 dust 500-750 g

SOIL

A soil pH of 6 to 7 is desirable for optimum growth of potatoes. However, lower pH values down to 5.0 may provide better control of scab. Apply limestone to rotation crops where possible, and in the fall if potatoes follow potatoes.

Soil organic matter can be maintained by use of well-decomposed barnyard manure, grass or legume sod crops, or cover crops. A thick cover crop seeded after early potatoes will reduce soil blowing and fertilizer leaching. Manure should be applied in the fall and incorporated.

POTATO (Continued)

FERTILIZER

SOIL TESTS are required to determine phosphate and potash requirements. **(See tables on pages 26 and 27.)**

NITROGEN — Apply 130 kg N/ha on MINERAL SOILS for MAIN CROP potatoes and 70 kg N/ha for early potatoes. Apply up to 60 kg N/ha on MUCK SOILS. If manure is applied or legume sod is plowed down, reduce the nitrogen application. **(See tables on pages 16 and 18.)**

APPLICATION — On MINERAL SOILS testing medium or low for phosphate, some or all of the phosphate fertilizer should be placed in bands 2.5 cm below and 6 cm to each side of the seed piece at planting time. On MUCK SOILS or on MINERAL SOILS testing high for phosphate, placement is less critical and fertilizer may be broadcast.

If the total N plus K_2O applied is over 360 kg/ha, at least a portion should be broadcast before planting to avoid too concentrated a band near the seed piece and potato roots. Broadcasting or side-dressing N after potatoes are 20 cm high is not generally recommended because it may delay maturity.

PLANT ANALYSIS — Samples for plant analysis should be taken from at least 50 plants distributed throughout the area chosen for sampling. Problem areas should be sampled separately. For potatoes, the fourth leaf, including stem, from the growing tip at early bloom is recommended. However, plants suspected of nutrient deficiency should be sampled as soon as the problem appears. Expert help will be required to interpret plant-analysis results when the samples are not taken at early bloom. A soil sample should be taken from the same area and at the same time as a plant sample. For more information on plant analysis, **see page 18.**

INTERPRETATION OF PLANT ANALYSIS FOR POTATOES

Nutrient	Units	Critical Concentration*	Maximum Normal Concentration**
Nitrogen	%	2.50	3.50
Phosphorus	%	0.15	0.50
Potassium	%	1.20	2.50
Calcium	%		1.50
Magnesium	%	0.10	0.60
Sulfur	%	0.14	
Boron	ppm (ug/g)	2	25
Copper	ppm	2	25
Manganese	ppm	15	150
Zinc	ppm	14	70

Values apply to the fourth leaf, including stem, from the growing tip at early bloom.

* *Yield loss due to nutrient deficiency is expected with nutrient concentrations at or below the critical concentration.*

** *Maximum normal concentrations are more than adequate but do not necessarily cause toxicities.*

DISEASE CONTROL

Practise a suitable crop rotation to prevent build-up in the soil of organisms causing blackleg, wilt, Rhizoctonia, common scab, early blight and silver scurf.

SEED-PIECE DECAY — See Seed Handling and Treatment.

COMMON SCAB — Choose a resistant cultivar suitable for the area and the market. See Soil Reaction, and Seed Handling and Treatment. Where irrigation is available, it is important to maintain high soil moisture for about 4 weeks after tuber setting begins where scab has been a problem.

POWDERY SCAB — Only a problem in northern Ontario. Plant Foundation or Certified seed. Plant in warm, well-drained soil. Do not plant in fields in which powdery scab has occurred.

RHIZOCTONIA — Avoid land known to be heavily infested. Rotate the crop, e.g., spring barley on mineral soil, or onions on muck soils. To reduce attacks on eyes and sprouts, plant to a depth of 8 to 10 cm without hilling. See Seed Handling and Treatment.

VERTICILLIUM WILT — On land where this disease was severe allow at least a 2-year rotation with a cereal, corn or other suitable non-Verticillium-susceptible crop. To be effective, a high degree of weed control is absolutely essential.

BACTERIAL RING ROT — See section on Sanitation. Do not save any of your own potatoes for seed.

BLACKLEG — (a bacterial disease) — See Seed Handling and Treatment and section on Sanitation. Planting whole seed may help reduce loss.

SPINDLE TUBER — Use Foundation or Certified seed. Inspect your seed carefully for signs of spindle-tuber infection **(See OMAF Publication 534, Potato Production in Ontario.)** If present in any significant amount, do not use as seed.

LEAFROLL VIRUS AND NET NECROSIS — Use Foundation or Certified seed. Because leafroll is spread by aphids, the control of this insect is important, especially with the cultivar Russet Burbank, to avoid net necrosis caused by current-season infection.

EARLY BLIGHT — Early blight is particularly damaging to the cultivars Norchip and Superior. Begin your fungicide spray program early so that lower plant foliage is well covered. This is where blight infections first begin. Conditions favourable for disease development are combinations of temperatures between 17-24°C and 12 hours of leaf wetness throughout the plant canopy. In addition, stress conditions, such as drought, insect damage, air pollution, rapid growth at tuber sizing, increase the foliage susceptibility to early blight. Under these conditions spray intervals should be shortened to 7 days.

POTATO (Continued)

LATE BLIGHT — **Destroy all culls.** Use a suitable vine killer early in the season on any foliage that may develop on over-wintered cull piles. Using a cultivar with tolerance or resistance to late blight makes the spray program more effective by reducing the chances of infection. Plant Certified seed. If requested, seed will be inspected by federal inspectors.

Healing of cuts and bruises is most rapid at a tuber temperature of 15 to 21°C. It is desirable to provide this temperature for 2 or 3 weeks at the beginning of the storage period. After this, the temperature should be lowered to 5°C if potatoes are intended for tablestock or seed. Potatoes intended for processing should be preferably maintained at 10°C and should never be subjected to temperatures below 5°C. It will be necessary to use a sprout inhibitor if potatoes are to be stored at 10°C for an extended period.

The relative humidity in the storage should be as high as possible without causing condensation of moisture on tubers and the storage structure. However, if soft rot is prevalent or if the tubers are wet when first put into storage, the humidity should be kept down until the tubers are dry.

EARLY AND LATE BLIGHT CONTROL

Use one of the following:

1. chlorothalanil
   Bravo 500 1.75-2.25 L (1 day)
2. captafol
   Difolatan 480 F 1.75-3.25 L (1 day)
3. mancozeb
   (i) Mancozeb 80 WP 2.25 kg (1 day)
   (ii) Dithane M-45 2.25 kg (1 day)
   (iii) Manzate 200 2.25 kg (1 day)
4. maneb
   (i) Dithane M22 2.25 kg (1 day)
   (ii) Maneb 80% WP 2.25 kg (1 day)
   (iii) Manzate D 2.25 kg (1 day)
5. metiram
   Polyram DF 2.25 kg (1 day)
6. metalaxyl/MZ
   Ridomil 72 W 2.5 kg (1 day). Use at 10-to 14-day intervals. For late blight only.

NEMATODES — **See page 29.**

INSECT CONTROL

SOIL INSECTS — Cutworms, Wireworms and White Grubs — **See pages 29 and 30.**

FOLIAGE INSECTS — Tarnished Plant Bugs, Leafhoppers, Flea Beetles, Colorado Potato Beetles

a. **Cultural Control.** Due to widespread development of insecticide resistance, Colorado potato beetle has become the most serious insect pest of potato foliage. Growers can reduce beetle populations by rotating potato production from field to field. In addition, vine killing as soon as possible in the fall and working down cull potatoes remaining in the field after harvest will remove preferred food supplies from the field, increasing winter mortality of late-season beetles.

b. **Soil Treatment. For main crop and seed potatoes only. Do not dig potatoes within 90 days of application.**
It is possible to control Colorado potato beetles, leafhoppers, flea beetles and aphids early in the season with one of the following granular materials applied in the furrow at planting time.

These chemicals are extremely toxic. Carefully follow all precautions given by the manufacturer.

1. aldicarb, Temik 10% G, 22.4 kg (90 days)
2. phorate, Thimet 15% G, 14.5-22.4 kg (90 days). Use the higher rate on heavy silt or clay loam soils. Do not use on muck soils.
3. carbofuran, Furadan 10% G, 32.5 kg (90 days). Does not control aphids.
4. disulfoton, Di-Syston 15% G, 15-22.5 kg or 720 LC 2.75-4.75 L (90 days). Do not allow the 720 LC formulation to come in contact with the seed-piece. For both formulations, use the high rate on clay and muck soils.

Note To reduce the possibility of groundwater contamination and slow the development of potato beetle resistance, alternate insecticides each year.

For **late-season** control, apply an appropriate foliar insecticide. If soil was treated at planting time with disulfoton or phorate, choose an insecticide from Group B or C; if it was treated with carbofuran or aldicarb, choose from Group A or B.

c. **Spray Program.** Regular field scouting provides accurate information on development and location of problem insect populations, increasing effectiveness of foliar sprays.

For example, young Colorado potato beetle larvae are much easier to control than adult beetles. Border sprays may provide adequate protection of new potato fields from migrating Colorado potato beetles.

To control insecticide-susceptible Colorado potato beetles, potato flea beetles, tarnished plant bugs or potato leafhoppers, use one of the following insecticides listed in groups A, B, C and D.

WARNING! In a number of counties and regions, Colorado potato beetles have developed at least 10-fold resistance to a number of the following insecticides:

Area A	Area B	Area C
Elgin	Essex	Brant, Elgin, Essex,
Huron	Huron	Haldimand-Norfolk,
Kent	Kent	Hamilton-Wentworth,
Lambton	Lambton	Huron, Kent, Lambton,
Prescott & Russell	Simcoe	Middlesex, Prescott & Russell, Simcoe, Waterloo

POTATO (Continued)

Not all populations in the listed regions will be resistant to these insecticides but growers in those regions should carefully monitor the effectiveness of spray applications. Resistance levels are highest for carbofuran (Group C) and endosulfan (Group D).

Growers with resistant Colorado potato beetles should consult their local OMAF Horticultural Crop Advisor and apply insecticides only from groups of insecticides still effective on their farms.

To slow the development of further resistance it is essential for all growers to alternate insecticides, choosing one from a different group each time a spray is applied. Young larvae are easier to control than adult beetles.

Group A

1. [1]methidathion
   [1]Supracide 240 EC 1.2 L (14 days)
2. [2]methamidophos
   [2]Monitor 480 EC 1.75-2.25 L (14 days)
3. chlorpyrifos
   Lorsban 4 E 1.0 L (7 days)
4. [2]azinphos-methyl
   [2]Guthion 240 SC 2.25 L (1.5 L for Colorado potato beetle) (7 days)
5. phosmet
   Imidan 50% WP 2.25 kg (7 days)

Group B

1. deltamethrin
   Decis 2.5 EC 200-300 mL (23 days)
2. fenvalerate
   Belmark 300 EC 100-150 mL (7 days)
3. permethrin
   (i) Ambush 500 EC 150-200 mL (1 day)
   (ii) Pounce 384 EC 185-250 mL (1 day)
4. cypermethrin
   (i) Ripcord 400 EC 90 mL (125 mL for tarnished plant bug) (7 days)
   (ii) Cymbush 250 EC 140 mL (200 mL for tarnished plant bug) (7 days)

Group C

1. [2]carbofuran
   [2]Furadan 480 F 1.1 L (550 mL for Colorado potato beetle) (7 days)
2. [1]oxamyl
   [1]Vydate L 2.3-3.0 L (7 days)

Group D

1. endosulfan
   (i) Thiodan 50% WP 1.1 kg (1 day)
   (ii) Thiodan 4 EC 1.4 L (1 day)
   (iii) Endosulfan 400 EC 1.5 L (1 day)

c. **Aphids** — For green peach, potato or Buckthorn aphids, apply one of the following:

1. [2]methamidophos
   [2]Monitor 480 EC 1.75-2.25 L (14 days)
2. pirimicarb
   Pirimor 50 W 450-550 g (3 days)
3. [2]oxydemeton-methyl
   [2]Metasystox-R 240 SC 1.75-2.25 L (7 days)
4. [1]oxamyl
   [1]Vydate L 3 L (7 days)
5. dimethoate
   Cygon 480 E 550 mL-1.1 L (7 days)
6. fenvalerate
   Belmark 300 EC 225-325 mL (7 days)

d. **Late-Season Cutworms** — have caused both tuber and foliage damage. Control of these cutworms can only be obtained when they are active above the soil surface prior to tuber migration and feeding. Thorough penetration of dense foliage is required for optimum control. Consult your local Horticultural Crop Advisor or Pest Management Advisor regarding insect adult flights to aid in spray-timing decisions.

Apply one of:

1. permethrin
   Ambush 500 EC 140 mL (1 day)
2. chlorpyrifos
   Lorsban 4 E 1.0 L (7 days)
3. cypermethrin
   Ripcord 400 EC 175 mL (7 days)

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[1]*Minimum period before reentry is 24 hours.*

[2]*Minimum period before reentry is 48 hours.*

SPROUT INHIBITION

After completion of a rest period, potatoes sprout readily. Potatoes treated with chemical sprout inhibitors can be stored at 10°C or higher without sprouting.

FIELD-APPLIED. Maleic hydrazide is a plant growth regulator applied as a single application in the field to control sprouting of potatoes in storage.

It should be applied in a manner that insures complete and uniform coverage. Timing is important. Recent research has shown that too early an application, on some cultivars, such as Norchip, may result in reduced potato size and phytotoxicity.

Consult manufacturer's recommendations and your local OMAF Horticultural Crop Advisor for more detailed information on both rates and timing. Time of application may occur as early as 2-3 weeks past full bloom. Only apply to plants that are still green and free from insects, disease and other damage.

Once in storage, tubers treated with maleic hydrazide will *not* affect seed potatoes stored in the same storage, or those stored in crates formerly used for the storage of maleic hydrazide-treated tubers.

POTATO (Continued)

STORAGE-APPLIED. CIPC is another chemical which is widely used for sprout inhibition.

Apply it in storage as a dip, spray or aerosol just before sprouting starts. Potato tubers may be treated with this chemical before packaging for market. Do not apply CIPC at harvest time.

Do not use either of these treatments on potatoes grown for seed. Do not store seed potatoes in the same storage with CIPC-treated tubers, or in crates which were in the storage when CIPC was applied.

VINE KILLING

Vine killing is especially important to growers of Certified seed, as an early kill controls tuber size and reduces the spread of virus diseases by aphids.

Chemical vine killers are not recommended for early potatoes because they limit the yield, size and dry matter content without reducing skinning.

Use diquat according to manufacturer's directions, which will vary according to plant vigour and the type of growing season. **Ensure that no drift occurs from any of these materials to adjacent crops** because the residue of these compounds on other crops may result in their seizure.

Allow at least 14 to 21 days between vine killing and harvesting so that skins of the tubers may set. For proper rate and time between application and harvest, consult labels for individual chemicals. If late blight is present, a quick kill is desirable; this may cause a slight darkening at the stem end of the tubers but will not change the specific gravity.

The use of roto-beaters is not recommended except where dead vines or weeds are a hinderance to the digger.

STORAGE

Store seed tubers separately from tablestock potatoes, in a clean storage. Do not store seed potatoes in the same storage with CIPC-treated tubers.

Healing of cuts and bruises is most rapid at a tuber temperature of 15 to 21°C. It is desirable to provide this temperature for 2 to 3 weeks at the beginning of the storage period. After this, the temperature should be lowered to 5°C if potatoes are intended for tablestock or seed. Potatoes intended for processing should be preferably maintained at 10°C and should never be subjected to temperatures below 5°C. It will be necessary to use a sprout inhibitor if potatoes are to be stored at 10°C for an extended period.

The relative humidity in the storage should be as high as possible without causing condensation of moisture on tubers and the storage structure. However, if soft rot is prevalent or if the tubers are wet when first put into storage, the humidity should be kept down until the tubers are dry.

RADISH

Radish, a cool-season crop, is adversely affected by hot, dry weather, and remains in prime condition only a few days. To be mild, tender and attractive, it must be grown rapidly with plenty of moisture. If growth is checked, the roots become hot, tough and pithy. Under medium to short daylength, roots are normally well shaped and tops relatively small. Under long days (15 hours), roots are misshaped, tops are long and usually produce seed stalks.

CULTIVARS
(Revised for 1990)

Main Crop	Jumbo	Bunching
Belle Glade	Champion	Revoso
Fuego	Red Crunchy	Saxafire
Red Cheriette	Scarlet Globe	Red Baron
Champion	Special	Galahand
Cherry Belle	Snow Belle (White)	

Cultivars or strains with globe-shaped roots entirely red in skin colour, and with leaves that are short to medium in length, are the most popular. Medium-top strains are preferable for early spring crops and short-top strains are preferable during the longer day period.

SEED TREATMENT

See Chemical Seed Treatment, page 31.

SEEDING AND SPACING

SEED — 11 to 17 kg per hectare. Use 22 to 34 kg/ha for machine harvesting.

SPACING — Rows 20 to 30 cm apart. Plants 40 to 50 per metre of row. For machine harvesting, space rows 10 to 15 cm apart.

SPRING CROP — The seed may be sown in the spring as soon as the soil is workable. Spring frosts, or even heavy snowfalls, after the plants have emerged, usually do not injure the crop seriously. Under favourable weather conditions, radish seedlings appear above ground 2 or 3 days after sowing. Sowing at intervals in the spring will provide a continuous harvest.

SUMMER AND FALL CROP — Radishes are grown successfully on muck soils throughout the growing season because such soils are usually well supplied with moisture and provide

RADISH (Continued)

a cool growing medium. Only large-sized seed of the short- to medium-foliage cultivars or strains of radishes should be used.

FERTILIZER

SOIL TESTS are required to determine phosphate and potash requirements **See tables on pages 26 and 27.**

NITROGEN — On MINERAL SOILS apply up to 60 kg N/ha. On MUCK SOILS apply 55 kg N/ha. If manure is applied or legume sod is plowed down, reduce the nitrogen application. **(See tables on pages 16 and 18.)**

INSECT CONTROL

CABBAGE MAGGOT — Spray plants at or just after emergence.
[1]parathion
[1]Parathion 15% WP 2.25 kg (15 days)

FLEA BEETLES — To limit the development of resistance, the two insecticides below should be used **alternately:**
1. permethrin
Ambush 500 EC 140 mL (2 days)
2. carbaryl
Sevin XLR Plus 1.25-2.5 L (7 days)

APHIDS — Spray with:
[1]parathion
[1]Parathion 15% WP 2.25 kg (15 days)

[1]*Minimum period before reentry is 7 days.*

RHUBARB

CULTIVARS
(Not revised for 1990)

Outdoor	Forcing
Timperley Early	Timperley Early
Valentine	Victoria
Macdonald	Sutton
German Wine	

SPACING

Rows 90 cm apart, plants 90 cm apart in the row (11,950 plants per hectare). To produce roots for forcing, spacing in the field may be adjusted to 75 cm between rows and plants (17, 220 plants per hectare) without any loss of yield or quality.

PLANT SELECTION

A number of virus and other diseases reduce the vigour of the plant and the yield, both in the field and in the forcing shed. Plants with vigorous growth should be marked during June and left in the field until the following spring, then dug up and used as planting stock. The remainder should be discarded.

FLOWER-STALK REMOVAL

Flower stalks should be cut out while they are still small, and in any case before the flowers open. This can conveniently be done at the same time as harvesting a crop for processing, but in crops grown for early fresh market, or for forcing, a separate operation will be necessary.

FERTILIZER

SOIL TESTS are required to determine phosphate and potash requirements. **(See tables on pages 26 and 27.)**

NITROGEN — Apply up to 280 kg N/ha.

APPLICATION - PREPLANTING — Plow under 45 to 90 tonnes/ha of manure in the fall. Broadcast and cultivate in 100 kg N/ha, with all of the phosphate and potash required, before planting.

ANNUALLY — Just before the buds break each spring apply 180 kg N/ha, with the phosphate and potash required (based on a soil test) as a broadcast dressing, or preferably as a side-dressing at a 10-cm depth. Immediately after pulling the crop for processing, apply broadcast 100 kg N/ha. The same amount may be applied in July to plants to be used for forcing.

IRRIGATION — As much as 100 kg N/ha may be applied through the irrigation system after pulling or in July for plants that are to be used for forcing.

DISEASE AND INSECT CONTROL

CROWN ROT AND VIRUS DISEASE (See Plant Selection) — Remove and destroy diseased plants. Only vigorous, normal plants should be used for propagation.

NEMATODES — **See page 29.**

POTATO STEM BORER — **Consult OMAF Factsheet, Potato Stem Borer in Ontario, Agdex 111/622.**

RHUBARB CURCULIO — Destroy dock weeds near the rhubarb planting.

Note: The use of gibberellic (Activol GA) is recommended for rhubarb forcing. Recommendations may be obtained from your Horticultural Crop Advisor.

RUTABAGA

For more details, consult **OMAF Factsheet, Rutabagas (Table Turnips), Agdex 258/20.**

CULTIVARS
(Revised for 1990)

Laurentian (strains)

SEED TREATMENT

Buy Registered seed that has been treated with a seed protectant such as thiram, captan, or streptomycin.

SEEDING AND SPACING

For the early crop (limited market), sow the seed when soil conditions allow seeding. The optimum soil temperature for germination is from 16 to 29°C. Sowings made after mid-June are more vulnerable to virus infection. Use up to 500 grams of seed per hectare. Plant to moisture, up to 1.5 cm deep.

Use seeders that space the seeds at known intervals, and use seed which has been precisely sized. This will eliminate or facilitate thinning and produce a highly uniform crop.

Where thinning is required, do so when plants are 4 to 8 cm high; space 15 cm apart in the row. Rows vary from 60 to 90 cm apart.

FERTILIZER

SOIL TESTS are required to determine phosphate and potash requirements. **(See tables on pages 26 and 27.)**

NITROGEN — Apply up to 35 kg N/ha. Manure may be used in the rotation at the rate of 18 to 22 t/ha, but it should be applied at least a year before the rutabaga crop is grown. If manure is applied or legume sod is plowed down, reduce the nitrogen application. **(See tables on pages 16 and 18.)**

SECONDARY AND MICRONUTRIENTS — BORON DEFICIENCY — Water-core or brown heart appears first in young, enlarging roots as firm, brownish, water-soaked patches. These may increase in size until almost the whole rutabaga root is affected. Severely affected rutabagas may turn punky inside later — after storage, rather than in the field. **Consult OMAF Factsheet, Brown Heart in Rutabaga, Agdex 258/690.**

BORON can be applied to the soil before sowing. The necessary quantity of boron can be mixed with the fertilizer which is applied before planting. Boron-enriched fertilizer should be applied as uniformly as possible.

Generally, foliar applications of Solubor are as effective as larger amounts applied to the soil. The first spray (foliar) application should be made when the roots of the plants are about 1.5 to 2.5 cm in diameter. The second and third applications may be applied at 10- to 14-day intervals after the first spray. Do not combine pesticides with boron sprays unless the label specifies compatibility. Excessive applications of boron will often adversely affect the succeeding crop in the rotation (e.g., soybeans, snap beans, white beans and small grains). For rates, **see page 25.**

DISEASE CONTROL

DAMPING-OFF — **See Seed Treatment (also see page 31).**

BLACK ROT AND BLACKLEG — Sow Registered seed. Do not plant rutabagas, rape, kale, cabbage, and other crucifers more than once in 4 or 5 years on the same land. Do not apply manure containing rutabaga refuse or diseased rutabagas on land intended for rutabagas. Do not work in the field when plants are wet. Never store diseased rutabagas. Clean out the storage each spring.

CLUBROOT — Use a crop rotation with non-cruciferous crops. Avoid fields known to be infested. **See under Cabbage, page 39.** (Note comment regarding calcitic lime.)

MOSAIC VIRUS — Losses from turnip mosaic virus are especially heavy in plantings sown after mid-June. Volunteer rutabagas and winter rapeseed are the main overwintering sources of the virus. Aphids carry the virus to the rutabaga crop. Aphicides do not prevent the spread of the virus. For virus control recommendations, **consult OMAF Factsheet, Turnip Mosaic Virus (TuMV) of Rutabaga, Agdex 258/635.**

NEMATODES — **See page 29.**

INSECT CONTROL

ROOT MAGGOTS

Do not grow early and late rutabagas in the same field or near winter rapeseed or early broccoli, cabbage and cauliflower. A **number of insecticides are effective. Each of these is highly toxic and spray operators must take full safety precautions when using and storing these chemicals** (see page 4). Safe disposal of empty bags and containers is equally important.

Cabbage maggot flies emerge early in the year (early May) and are present in 3 (occasionally 4) generations throughout the season. There are two distinct periods of damage related to the emergence of the 3 generations of flies: early in the season (prior to June 20), occasionally during July, and late (after mid-August). Therefore, control of root maggots can be timed to coincide with the peak activity of each generation of adults. In some areas, monitoring programs are carried out for cabbage maggot. Consult your Pest Management Advisor for timing of insecticide applications..

EARLY AND LATE CROP

Use one of the following granular insecticides in a 5-10 cm band at planting time. Cover 12 to 25 mm deep.

1. carbofuran
   Furadan 10% G 25 kg (for 70 cm row spacing)
2. terbufos
   Counter 15% G 20 kg
3. chlorpyrifos
   Lorsban 15% G 13.5 kg

OR

Apply a drench spray in a 10-15 cm band over the row just prior to plant emergence. Use one of:

1. [2]carbofuran
   [2]Furadan 480 F 5.0 L (40 days)

RUTABAGA (Continued)

Note: All rates are for 75 cm row spacings; for other row spacings, check label directions.

Regardless of whether the granular or drench procedure is used for the first application, follow with a drench spray in a 10-15 cm band over the row 5 weeks after the first application or at the start of peak activity of second generation cabbage maggot flies.

Use:

1. [2]carbofuran
   [2]Furadan 480 F 5.0 L

For the late crop, follow with a third application after an additional 5 weeks (mid-August), or at the start of peak activity of third generation flies, with the following:

1. [2]carbofuran
   [2]Furadan 480 F 5.0 L

Note: Carbofuran should *not* be used for control of third generation root maggots on rutabagas to be exported to the United States. There is no tolerance for residues of carbofuran on rutabagas in the U.S.

A fourth application with fensulfothion may be required when there is a high level of maggot activity late in the season. **Observe the days-to-harvest interval.**

In some areas carbofuran is not providing good control. Growers who experience poor control with this insecticide should consult a Pest Management Advisor.

FLEA BEETLES — These insects can be controlled only in the adult beetle stage. There is no control for larvae established in roots. A spray should be applied as soon as the beetles appear in the field. Because beetles may migrate into the field over several weeks, a number of applications may be required.

If insecticide drenches (carbofuran) are used to control root maggots, **flea beetles** may also be controlled. If drenches are not applied before seed emergence and seedlings are attacked when they come up, or if beetles are numerous during the growing season, spray with one of the following materials. To limit the development of resistance, alternate between insecticide groups A, B and C for each application.

Group A

1. carbaryl
   Sevin XLR Plus 1.25-2.5 L (7 days)

Group B

1. permethrin
   Ambush 500 EC 140 mL (before 8-leaf stage)
2. cypermethrin
   Cymbush 250 EC 200 mL (21 days)

Group C

1. endosulfan*
   (i) Thiodan 4 EC 2.0 L (45 days)
   (ii) Endosulfan 400 EC 2.0 L (45 days)
   **Use no more than 2 applications per season.*

APHIDS — If the crop is threatened, spray with one of the following insecticides. These insecticides are not likely to be effective against aphids if combined with boron sprays.

1. oxydemeton-methyl
   Metasystox-R 240 SC 1.75-2.25 L (14 days)
   (Use no more than 2 applications per season)
2. dimethoate
   Cygon 480 E 0.7 L (7 days)
3. [3]parathion
   [3]Parathion 800 EC 400-700 mL (15 days)
4. endosulfan*
   (i) Thiodan 4 EC 2.0 L (45 days)
   (ii) Endosulfan 400 EC 2.0 L (45 days)
   **Use no more than 2 applications per season.*

LEAF-EATING CATERPILLARS — If cabbageworms, cabbage loopers, zebra caterpillars, etc., are numerous, spray with one of:

1. Bacillus thuringiensis
   Dipel 0.5-1.1 kg (0 days)
   (Use higher rates for looper control)
2. endosulfan*
   (i) Thiodan 4 EC 2.0 L (45 days)
   (ii) Endosulfan 400 EC 2.0 L (45 days)
   **Use no more than 2 applications per season.*

CUTWORMS (See page 30) — To control dark-sided cutworm, black cutworm, and red-backed cutworm use:

1. chlorpyrifos*
   (i) Lorsban 4E 1.2-2.4 L (30 days)
   (May be used at the rate of 2.4 L as a preplanting treatment)
   (ii) Lorsban 25 WP 1.125-2.25 kg (30 days)
   **Apply once at seedling stage (2-5 leaves) when damage first appears.*

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[2]*Minimum period before reentry is 48 hours.*
[3]*Minimum period before reentry is 7 days.*

HARVESTING AND WASHING

Avoid bruising. Damaged and bruised rutabagas are likely to rot and do not store well.

Dirty water contains large numbers of rot-causing organisms. To reduce loss from disease after waxing, change water in the wash tank frequently or add fresh water continuously to keep water as clean as possible. Then spray-rinse rutabagas with clean water and dry them as rapidly as possible before waxing or shipping. Trimming after washing helps reduce rot in waxed rutabagas. Sodium hypochlorite in the rinse water has been shown to be effective in reducing losses after waxing.

STORAGE

Clean the storage thoroughly in the spring. To disinfect the storage, spray all surfaces with a mixture of copper sulfate (bluestone) 1 kg, hydrated lime 2 kg, dissolved in 50 litres of water. Add lime last. Since this mixture is corrosive to metals, cover metal fixtures such as fans, electrical control equipment, etc.,

RUTABAGA (Continued)

during the spraying operation. An alternative disinfectant spray is a 1:240 solution of formaldehyde. **Follow all precautions.**

Do not spread refuse from the storage onto land that may be used for rutabagas.

Never put diseased rutabagas in storage. Disease-free rutabagas will keep up to 6 months if stored at 0°C and a relative humidity of 90 to 95%. Adequate ventilation and air movement throughout the storage are necessary.

Before feeding rutabaga tops or trimmings to livestock, check pesticide labels for warnings.

Do Not! . . . Feed Vegetables Treated With ENDOSULFAN to Livestock or Poultry

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SPINACH

CULTIVARS
(Revised for 1990)

Mineral Soil	Muck Soil	
Long Standing Bloomsdale	(Tolerant to Bolting)	
(spring)	Wobli	1*
Tyee	Tarantella	3
(summer, fall)	Mazurka	1
Melody	Norveto	3
(summer, fall, overwintering)	Estivato	2
	Symphony	1
	Melody	2

**1 = smooth leaf; 2 = medium leaf; 3 = savoyed leaf*

BOLTING

Spinach quickly bolts (produces flower stalks) under long-day and warm-weather conditions. This explains why the crop is produced mostly in the spring or fall. Cool weather reduces the long-day effect. Spinach grown in cool summers may not bolt quickly.

Bolting may also be hereditary. Strains of spinach deteriorate in quality if the seed producer allows the quick-bolting types to increase.

SEED TREATMENT

Treat seed with a thiram or captan seed protectant.

SEEDING AND SPACING

Sow outside as soon as soil can be worked in early spring until early May, or from July 31 to August 31 for a fall crop. Do not sow seed in midsummer because bolting may occur. For over-wintered spinach, sow from September 1 to 10. About 12 kg of seed will plant one hectare.

Fresh seed will germinate readily at soil temperatures as low as 3 to 4°C, and good results are obtained at 10 to 16°C. At higher temperatures there is a more rapid emergence, but decreased percentage germination. The ability to germinate in cool soil permits very early sowing in spring.

Spinach seed more than a year old rarely germinates over 80%. Older seed is even less viable and germinates more slowly and irregularly.

Space rows 30 cm apart, and plants 5 to 10 cm in the row.

SOIL

Sandy soils are preferred for the early and overwintered crops. The highest yields are obtained on muck soils. Muck soils have a high water-holding capacity, but are well-aerated. From such soils the harvested crop contains a minimum of sand or other gritty material. Since spinach is somewhat sensitive to soil acidity, a test should be made before planting the crop.

FERTILIZER

SOIL TESTS are required to determine phosphate and potash requirements. **(See tables on pages 26 and 27.)**

NITROGEN — On MINERAL SOILS apply up to 110 kg N/ha. On MUCK SOILS apply 75 kg N/ha. If manure is applied or legume sod is plowed down, reduce the nitrogen application. **(See tables on pages 16 and 18.)**

APPLICATION — On MINERAL SOILS, for a very early planting, all of the nitrogen may be applied at planting time.

For a mid-season or later crop, apply half the recommended amount of nitrogen at planting time.

Side-dress the mid-season or late crop with 55 kg N/ha following excessive rainfall, especially on sandy soils.

On MUCK SOILS, although the recommended amount of nitrogen should normally be considered maximum, it may be permissible following excessive rainfall to side-dress with an additional 55 kg N/ha.

DISEASE CONTROL

DAMPING OFF — **See Seed Treatment (also see page 31).**

DOWNY MILDEW AND MOSAIC — Grow a resistant cultivar. Do not grow a fall crop in, or adjacent to, a field where an infected spring crop was grown.

FUSARIUM WILT AND ROOT ROT — In soils where this disease is a problem, do not seed spinach between May 31 and August 15.

NEMATODES — To avoid damage from sugar beet nematode, do not plant spinach following rhubarb, beets or spinach.

SPINACH (Continued)

INSECT CONTROL

LEAFMINER — Spray when mines first appear. Use one of:

1. [3]parathion
   (i) [3]Parathion 15% WP 2.25 kg (7 days)
   (ii) [3]Parathion 960 E 350 mL (7 days)
2. malathion
   (i) Malathion 25% WP 5.5 kg (7 days)
   (ii) Malathion 500 EC 2.5 L (7 days)
3. diazinon
   (i) Diazinon 50% WP 1.1 kg (10 days)
   (ii) Diazinon 500 EC 1.1 L (10 days)

APHIDS — Use one of:

1. endosulfan*
   (i) Thiodan 50% WP 1.75 kg (14 days)
   (ii) Thiodan 4 EC 2.0 L (14 days)
   **Make only one application*
2. diazinon
   (i) Diazinon 50% WP 1.1 kg (10 days)
   (ii) Diazinon 500 EC 1.1 L (10 days)
3. [3]parathion
   (i) [3]Parathion 15% WP 2.25 kg (7 days)
   (ii) [3]Parathion 960 E 350 mL (7 days)
4. dimethoate
   Cygon 480 E 0.7 L (7 days)

CABBAGE LOOPER — Use one of:

1. Bacillus thuringiensis
   (i) Thuricide HPC 4.5 L (0 days)
   (ii) Dipel WP 1.1 kg (0 days)
2. endosulfan*
   (i) Thiodan 50% WP 1.7 kg (14 days)
   (ii) Thiodan 4 EC 2.0 L (14 days)
   **Make only one application.*
3. [3]parathion
   (i) [3]Parathion 15% WP 2.25 kg (7 days)
   (ii) [3]Parathion 960 E 350 mL (7 days)

[3]*Minimum period before reentry is 7 days.*

Handy Metric Conversion Factor

Litres per hectare x 0.4 = litres per acre
Kilograms per hectare x 0.4 = kilograms per acre

TOMATO

CULTIVARS FOR CLIMATIC ZONES IN ONTARIO
(Revised for 1990)

FRESH MARKET	ZONES (See Figure 1, page 12)		HOME PROCESSING (PYO)
Cultivars (in order of Maturity)	A & B	C, D & E	Cultivars (in order of maturity)
1. TH 318*	X	X	1. TH 318
2. Ultra-sweet *(trial)*	X	X	2. Bellstar
3. Summerset *(trial)*	X	X	3. FM 6203
4. Pik Red*	X	X	4. Ohio 7814
5. Pik Rite*	X	X	5. Veepick
6. Pilgrim *(trial)*	X	—	6. Ohio 8245 *(trial)*
7. Red Star *(trial)*	X	—	
8. Jet Star	X	X	
9. Mountain Pride*	X	—	

X *Indicates suitability of cultivars in each zone.*
* *Cultivars suitable for shipping.*

CULTIVARS FOR COMMERCIAL PROCESSING
Follow processors' requirements

CULTIVAR DESCRIPTIONS
Fresh Market

Jet Star — Verticillium-resistant F_1 hybrid, mid-season, large flattened-globe fruit. Suitable for staking.

Mountain Pride — Resistant to both Verticillium and Fusarium, F_1 hybrid, crack resistant, medium-sized, very firm fruit, excellent shipper. Suitable for staking.

Pik Red — Verticillium-resistant F_1 hybrid, mid-season, large, very firm, globe-shaped fruit, dark green shoulder, excellent shipper. Excessive nitrogen may promote cracking and yellow top.

Pik Rite — Verticillium-resistant; F_1 hybrid; mid-season; large, firm, globe-shaped fruit; better foliage cover than Pik Red; excellent shipper.

Pilgrim (trial) — Early mid-season, Verticillium resistant, uniform shoulder, good crack resistance, globe-shaped fruit, fruit size limiting under drought stress.

TOMATO (Continued)

Red Star (trial) — Late mid-season, Verticillium resistant, light green shoulder, large fruit size, good crack resistance.

Summerset — Verticillium-resistant F_1 hybrid, early bush type, somewhat open foliage, generally similar to Basketvee but firmer and more productive.

TH 318 — Early, compact open plant, variable fruit size, depending on conditions, generally good fruit quality. Additional nitrogen may be necessary.

Ultra Sweet — Verticillium resistant F_1 hybrid, mid-early indeterminate growth habit, crack resistant, large fruit. Suitable for staking.

Home Processing

Bellstar — Verticillium resistant. Early, jointless, pear shaped, fairly large, firm and well-coloured fruit on a compact vine with good concentrated maturity.

FM 6203 — Verticillium resistant, mid-season, medium-sized square-round fruit with excellent firmness.

Ohio 7814 — Verticillium resistant, mid-season, medium-sized plum-shaped fruit, well-coloured and firm, very productive, excellent for wholepack.

Ohio 8245 — Late mid-season, Verticillium resistant, plum-shaped fruit, medium fruit size, good concentration of maturity and field storage, avoid excessive nitrogen applications as this may delay maturity and cause yellow shoulder.

TH 318 — See under Fresh Market.

Veepick — Verticillium resistant, large pear-shaped fruit with good flavour, good yields. Well suited for PYO.

Note: All cultivars have determinate (bush type) growth and uniform green shoulders unless otherwise noted.

SEED TREATMENT

Sow acid-treated seeds for bacterial canker disinfection or hot-water-treated seed (**page 31**). Treat dry seed with thiram seed protectant.

GROWING THE PLANTS

Since tomatoes require a relatively long growing season, they should be started in a greenhouse or hotbed. Sow seeds at a rate of 8 seeds per 25 mm at a depth of 6 mm in shallow flats about 8 weeks before field transplanting. A temperature of about 27°C for 1 to 2 weeks is required for good seed emergence.

When the seedlings are approximately 4 cm high or when the first true leaves appear, transplant them into other flats containing a fertile compost soil. The plants should be spaced 5 to 7 cm apart. Seedlings can also be transplanted into clay or peat pots or to veneer or paper bands.

Tomato plants can also be raised by sowing raw seed directly into peat pots, multi-pot trays, seedling flats or directly into beds filled with special growing media. Under such a planting system, usually a superior plant can be raised in a shorter time. This system is less labour intensive and reduces transplant shock.

Growing-media information can be obtained from OMAF Publication 365 or from your local Horticultural Crop Advisor. Under no circumstances should large amounts of fresh manure or mushroom compost be added to a soil or soilless mix, as a dangerously high salt level in the growing medium will result in stunting, poor germination and death of young tomato plants. Where the salt level is in question, growing media should be analyzed prior to planting.

Tomato plants should be hardened for about one week before transplanting to the field. This can be accomplished by reducing the soil moisture supply, and reducing the air temperature to 13-16°C. Hardening-off improves the survivability of the plants to adverse weather conditions when field-set.

TRANSPLANTS

Use only plants which are disease-free and well grown. Sturdy, slowly grown plants are best. Recovery of severely hardened plants is slow and never complete. Plants of early-maturing, highly determinate cultivars should be relatively young and free from blossoms or visible blossom buds. Late cultivars are transplanted earlier than highly determinate cultivars, as growing conditions are usually less favourable early in the season.

TRANSPLANT STORAGE

Adverse weather conditions often disrupt field transplanting, forcing storage of crated, Southern transplants. The following storage practices will assist in maintaining a high plant-survival rate:

1. Open and check all crates to see that plants are dry and in good condition; remove moldy bundles.
2. Store plants in sheltered area (open sheds or barns); avoid hot, dry winds.
3. Keep foliage of plants dry; never sprinkle water on foliage during storage.
4. Avoid exposing the crates to temperatures above 10 to 12°C.
5. Do not hold transplants longer than 10 days.

DIRECT SEEDING

Select fields that have a low to medium weed-population pressure. This factor combined with early and precise cultivation after emergence will make weed control more effective.

Prepare a seedbed that is shallow and retains soil moisture as close to the soil surface as possible. Seed at 600 to 1100 grams per hectare (30 to 65 seeds per metre of row) or sow 4 to 6 seeds per clump every 20 to 30 cm. With clump seeding, place an anti-crustant (vermiculite) above the seed clump for better seedling emergence.

Use early to mid-season cultivars with compact plant type. Sow from early May to May 25 for mid- to late September harvest. Sow seed into moist soil as shallow as possible to achieve quick and uniform emergence. Thin seedlings at the second to fourth true-leaf stage to a stand with plants 22 to 30 cm apart.

SEEDING AND SPACING

Approximately 75 to 150 grams of seed are required to produce enough plants for one hectare.

TOMATO (Continued)

RECOMMENDED PLANT SPACING

	Fresh Market	Processing		
		Machine Harvest		Hand Pick
		Single Row	Twin Row	
Rows:	1.2 m	1.5 m	1.5 to 1.65 m	1.2 to 1.5 m
Plants:	30-45 cm	30 cm	45 x (30-45) cm	36 to 60 cm

NOTE: Twin-row spacing may enhance production. Consult your area Horticultural Crop Advisor or processor field representative.

FERTILIZER

SOIL TESTS are required to determine phosphate and potash requirements. **(See tables on pages 26 and 27.)**

NITROGEN — Apply up to a maximum of 90 kg N/ha.

APPLICATION — For some early cultivars of poor vigour, such as H2653 and TH318, apply 65 kg N/ha broadcast and side-dress 25 kg N/ha 3 weeks after transplanting. On sandy soils with low organic matter, following excessive rainfall, side-dress with an additional 20 kg N/ha. Side-dressing too late may delay harvest and reduce Ethrel response.

For direct-seeded processing tomatoes, apply 25% less nitrogen. If direct-seeded tomatoes are side-dressed, they should receive this side-dressing 4 weeks after plants emerge from the soil.

STARTER SOLUTION — (ALL TOMATOES) — At transplanting apply a starter solution high in phosphorus such as 1 L of 10-34-0 per 100 L of water or 1 L of 6-24-6 per 75 L of water. Under high-temperature conditions or in dry sandy soils, reduce the amount of fertilizer by one-half but continue to use the same volume of water. This will reduce the risk of crop injury under these growing conditions.

DISEASE CONTROL

A. IN THE SEEDBED

1. Sow acid-treated (preferred method) or hot-water-treated seed. **(See page 31.)**
2. Treat seed with thiram. See Seed Treatment.
3. Steam or fumigate soil with Vorlex, dazomet, or methyl bromide*.
4. Disinfect all greenhouse walls, benches and equipment.
5. Avoid unnecessary movement through the plants.
6. Immediately after sowing or transplanting, drench soil with captan 50% WP or 80% WP (see label).
7. When first true leaves develop, spray with one of the copper bactericides tank mixed with either mancozeb or maneb at 11 g product per 50 m^2. Repeat spray every 7 to 10 days.

**A permit issued by the Ontario Ministry of the Environment is required to use methyl bromide.*

B. IN THE FIELD

BACTERIAL CANKER, BACTERIAL SPECK, BACTERIAL SPOT, SOUTHERN BACTERIAL WILT — It is not possible to control tomato bacterial diseases in the field with chemical sprays.

ANTHRACNOSE, EARLY BLIGHT, LATE BLIGHT — Spray when first fruits are about walnut size (or when first fruits appear on early cultivars). Repeat sprays as necessary. During continuous moist weather, intervals should be 5 to 7 days. In warm, dry weather, intervals can be extended to 12 to 14 days if diseases are under control. For anthracnose, continue spraying until mid-September.

There are no practical control measures for tomato bacterial diseases after they are found in the field. Seed-borne bacterial canker can be prevented by soaking the seeds in hydrochloric acid **(see page 31)**, especially in transplants that are not clipped. Avoid working in tomato fields when the foliage is wet.

TOM-CAST is a program to help growers determine when to apply foliar fungicides in field tomatoes. It is designed for the control of early blight, septoria leaf spot and fruit anthracnose. A network of mini weather stations throughout the tomato-growing regions of Ontario are used to monitor conditions favorable for disease development from which disease severity values are calculated for each day throughout the summer. Growers are advised to spray at critical values through agriphone messages. Individuals interested in using or learning more about the system should contact their local Horticultural Crop Advisor or Pest Management Advisor.

Use one of:

1. captafol
   Difolatan 480 F 2.75 L (1 day)
2. chlorothalanil
   Bravo 500 2.8-3.2 L (1 day) (Under heavy disease pressure, use higher rate.)
3. mancozeb
   (i) Mancozeb 80 WP 3.25 kg (1 day)
   (ii) Dithane M-45 3.25 kg (1 day)
   (iii) Manzate 200 3.25 kg (1 day)
4. maneb
   (i) Maneb 80% WP 3.25 kg (1 day)
   (ii) Dithane M22 3.25 kg (1 day)
   (iii) Manzate D 3.25 kg (1 day)
5. metiram
   Polyram 80 DF 3.25 kg (1 day)

SEPTORIA LEAF SPOT — Spray with:

1. chlorothalanil
   Bravo 500 3.8 L (1 day)

FUSARIUM WILT, VERTICILLIUM WILT — Crop rotation is recommended. Grow Fusarium and Verticillium wilt-resistant cultivars if suited to area and market.

VIRUS DISEASE (MOSAIC, STREAK, GRAY WALL) — Grow seedlings in steamed soil in greenhouses and frames devoted to tomato seedlings only. Control aphids in seedbeds. Do not handle tobacco in any form when handling plants. Wash hands with soap and water before handling tomato plants. Do

TOMATO (Continued)

not harden transplants by leaving them in headlands or other weedy places. Cultivators should not be used in a healthy crop after use in an infected crop.

BLOSSOM-END ROT — This disorder is not caused by a disease organism. It is associated with calcium deficiencies in the plant and/or moisture stress (due to drought or excessive fertilizer use). The disorder may be reduced by maintaining uniform soil moisture (**see Irrigation, page 28**) and by avoiding close, deep cultivation when plants are large.

NEMATODES — **see page 29.**

INSECT CONTROL

VARIEGATED CUTWORMS — Chemical control is obtained only when insects come in contact with the insecticide. Control is therefore related to how effective the spray coverage is on the larvae. Early detection and control are essential, as larger insects are more difficult to control.

Spray with one of:

1. permethrin
   Ambush 500 EC 140 mL (1 day)
2. [1]methomyl
   [1]Lannate L 1.1-2.25 L (1 day). If numerous large larvae (2.5-3.0 cm) are found, use higher rate.
3. carbaryl
   Sevin XLR Plus 1.25 L (2 days)

FLEA BEETLES — Before field setting, spray with carbaryl 50% WP 60 grams or 85% WP 45 grams in 25 L of water. If a spray in the field is required, use one of the following in 1000 L of water:

1. carbaryl
   Sevin XLR Plus 1.25 L (2 days)
2. endosulfan
   (i) Thiodan 50% WP 1.1 kg (2 days)
   (ii) Thiodan 4 EC 1.4 L (2 days)
   (iii) Endosulfan 400 EC 2.75 L (2 days)
3. permethrin
   Ambush 500 EC 200 mL (1 day)
4. [2]azinphos-methyl
   (i) [2]Guthion 240 SC 2.25 L (2 days)
   (ii) [2]APM 50% WP 1.5 kg (2 days)

APHIDS — Control needed infrequently. Spray with one of:

1. diazinon
   (i) Diazinon 50% WP 1.0-1.75 kg (1 day)
   (ii) Diazinon 500 EC 1.1-2.0 L (1 day)
2. dimethoate
   Cygon 480 E 550-700 mL (7 days)
3. malathion
   Malathion 500 EC 1.25 L (3 days)

Note: Not effective below 18°C.

4. endosulfan
   (i) Thiodan 50% WP 1.1 kg (2 days)
   (ii) Thiodan 4 EC 1.4 L (2 days)
5. [1]methomyl
   [1]Lannate L 1.25-2.25 L (1 day)

Good spray coverage is required for aphid control. Repeated spray applications may be required when weather conditions favour rapid build-up of aphids. The two types of aphids affecting tomatoes are the potato aphid and the green peach aphid, the latter being more difficult to control.

TARNISHED PLANT BUGS — Dimethoate, when used to control aphids, will also give some control for tarnished plant bug.

COLORADO POTATO BEETLE — Regular field scouting provides accurate information on development and location of problem insect populations, increasing the effectiveness of foliar sprays. For example, young Colorado potato beetle larvae are much easier to control than adult beetles. Border sprays may provide adequate protection of new tomato fields from migrating Colorado potato beetles.

WARNING In a number of counties and regions, Colorado potato beetles have developed at least 10 fold resistance to a number of insecticides. **Refer to page 67** in the Potato section for details and advice.

To control insecticide-susceptible Colorado potato beetles, use one of the following insecticides and repeat as necessary. To slow development of further resistance it is essential for all growers to alternate insecticides, choosing from a different group each time a spray is applied.

Group A

1. [2]azinphos-methyl
   (i) [2]Guthion 240 SC 1.75 L (2 days)
   (ii) [2]APM 50% WP 0.85 kg (2 days)

Group B

2. permethrin
   Ambush 500 EC 200 mL (1 day)

Group C

3. carbaryl
   Sevin XLR Plus 1.25 L (2 days)

HORNWORMS — If hornworms are present, spray with one of:

1. permethrin
   Ambush 500 EC 200 mL (1 day)
2. carbaryl
   Sevin XLR Plus 2.5-5.25 L (2 days)
3. endosulfan
   (i) Thiodan 50% WP 1.1 kg (2 days)
   (ii) Thiodan 4 EC 1.4 L (2 days)
4. Bacillus thuringiensis
   (i) Thuricide HPC 725 mL - 1.5 L (0 days)
   (ii) Dipel WP 275-550 g (0 days)

TOMATO (Continued)

5. [2]azinphos-methyl
   (i) [2]Guthion 240 SC 2.25 L (2 days)
   (ii) [2]APM 50% WP 0.85 kg (2 days)

DROSOPHILA (fruit fly) — In the field — apply one of:

1. diazinon
   Diazinon 50% WP 1.75 kg (1 day)
2. naled
   Dibrom 8.64 EC 1.1 L (4 days)
3. [2]azinphos-methyl
   (i) [2]Guthion 240 SC 2.25 L (2 days)
   (ii) [2]APM 50% WP 0.85 kg (2 days)

Picked fruit — Spray or dust fruit and containers with a commercial mixture containing pyrethrins and piperonyl butoxide at rates given on the label. This spray or dust is permitted on all types of tomatoes.

CABBAGE LOOPERS — If cabbage loopers are a problem, spray with:

1. Bacillus thuringiensis*
   (i) Thuricide HPC 4.25 L (0 days)
   (ii) Dipel WP 1.1 kg (0 days)
   **This material is much more effective against small larvae.*

SAP BEETLES — Since there is no suitable insecticide to control sap beetles in the field, practise the following cultural controls to reduce the incidence of sap beetles in the fruit:

1. Leave roadways in the field at suitable intervals to allow movement of farm vehicles without squashing fruit.
2. Minimize crushing and squashing of fruit at picking time.
3. Pick as close as possible to time of delivery to the factory.
4. If loaded wagons are not delivered immediately, leave them exposed to air circulation rather than in a protected area.

GRASSHOPPERS AND CRICKETS - - Maintain weed-free borders and fencerows. If these insects are a problem, spray around the edge of the field with [2]azinphos-methyl ([2]Guthion 240 SC) at 2.25 L (2 days).

[1] *Minimum period before reentry is 24 hours.*
[2] *Minimum period before reentry is 48 hours.*

RING-BILLED GULL CONTROL

Ring-billed gull populations are increasing and are moving further inland along the shores of Lake Erie and Ontario. Tomato fruits are damaged by repeated feeding scars, resulting in reduced yields and quality, and increased sorting costs. Overall population control is not feasible; however, growers wishing to protect areas within a field can obtain a licence to shoot gulls. Early gull detection and control are important. For a permit, call the Enforcement Co-ordinator, Canadian Wildlife Service, Ontario Region, 152 Newbold Court, London, Ontario.
Phone: (519) 681-0486.

CHEMICAL FRUIT RIPENING

Use ethephon (Ethrel) for uniform ripening and once-over harvest and to enhance ripening in the late cultivars or during late seasons. For best results, ethephon should be applied to fields in good condition; plants which are stressed (wilted or damaged by disease or insects) will not respond satisfactorily.

Ethephon is effective only on fruits that are mature green (i.e. when cutting fruit with a sharp knife, seeds should remain uninjured, protected by a gelatinous pulp). With most processing cultivars, the time of application is when the maximum number of fruit has reached the mature green stage; this occurs when 5 to 20% of the fruit is showing red colour development. Good spray coverage on fruit and foliage is essential for maximum effectiveness. Use 3.75 to 7.50 L in 500 to 1000 L of water per hectare. Use higher rates when day temperatures are below 18°C and also when plant growth is dense. If plants are under stress, avoid use of ethephon or apply it at reduced rates. Excessive rates of ethephon will cause defoliation which will result in reduced fruit quality. Cool temperatures will delay colour development, and extend period between treatment and harvest. Generally, fruit is ready to harvest 14 to 21 days after treatment.

Ethrel is not registered for use on fresh market tomatoes!

Handy Metric Conversion Factor

Litres per hectare x 0.4 = litres per acre
Kilograms per hectare x 0.4 = kilograms per acre

PUBLICATIONS FOR VEGETABLE GROWERS

MINISTRY OF AGRICULTURE AND FOOD PUBLICATIONS

Publications available from Consumer Information Centre, 801 Bay St., Ontario Ministry of Agriculture and Food, Toronto, Ontario M7A 2B2 or from the Horticultural Crop Advisor or Pest Management Advisor serving your area.

NUMBERED PUBLICATIONS

No.	
40	*Greenhouses
63	*Farm Roadside Marketing in Ontario
73	Handbook of Drainage Principles
75	Guide to Weed Control
365	Greenhouse Vegetable Production Recommendations
485	Growing Vegetable Transplants
486	Onions
501	*Farm Drainage
502	*Rutabagas
505	*Ontario Weeds (from Communications Branch) $5.00
515	*Farm Ponds
534	Potato Production in Ontario
	Catalogue of Plans for Fruit and Vegetable Buildings and Equipment

AGDEX FACTSHEETS

AGDEX	
110/622	*Armyworm
111/622	European Corn Borer
111/622	Potato Stem Borer in Ontario
111/632	*Head Smut of Corn
111/685	*Bird Damage to Corn
161/635	Black Scurf and Silver Scurf of Potatoes
161/635	*Dry Rots of Potatoes in Storage
161/635	Ring Rot of Potato
161/745	Reducing Mechanical Injury in Potato Handling
200/545	*Metal Chelates in Horticulture
200/691	*Air Pollution and Horticulture Crops
202/51	Pick-Your-Own Harvesting
202/65	Storage Incompatibility
202/744	*Improving Spray Coverage on Row Crops
210/744	*Application Technique with Air-Blast Sprayers
250/22	*High-Density Planting of Vegetable Crops
250/23	Precision Seeding Vegetable Crops
250/24	*Polyethylene Mulches in Vegetable Crops
250/26	Pollination of Vegetable Crops
250/60	Home Storage of Vegetables
250/541	*Starter Solutions for Vegetable Crops
250/560	Irrigation of Vegetable Crops
250/612	Thrips on Onions and Cabbage
252/20	Chinese Cabbage Production in Southern Ontario
252/20	Production and Handling of Broccoli
252/64	*Storage of Cabbage
252/612	*Cabbage Loopers
252/612	*Cabbageworm
252/635	Bacterial Diseases of Cruciferous Crops
252/635	*Bacterial Leaf Spot of Cauliflower
252/635	Fungal Diseases of Cruciferous Crops
252/690	*Hollow Stem in Broccoli
243/22	Scheduled Planting of Sweet Corn
254/13	*Commercial Asparagus Production
254/13	Growing Rhubarb
254/57	Maintaining Asparagus Quality from Producer to Consumer
254/625	Insect Pests of Asparagus
254/635	Diseases of Asparagus
255/20	Peas for Processing
255/630	*Fungal Diseases of Field and Snap Beans
256/20	Growing Pickling Cucumbers
256/20	Muskmelon Production
256/26	Pollination of Vine Crops
256/51	Mechanical Harvesting of Cucumbers
256/821	Mechanical Harvesting of Pickling Cucumbers — Economic Aspects
257/13	Atlantic, Norchip and Monona Potatoes
257/13	Conestoga and Superior Potatoes
257/13	*Growing Peppers
257/13	*Jemseg Potato
257/13	Shepody Potato
257/13	Yukon Gold Potato
257/21	*Production of Potatoes for Processing
257/22	Field Seeding of Tomatoes
257/25	Tomato Fruit Diseases
257/25	Potato Quality
257/28	Growing Potatoes from True Potato Seed
257/52	Saving Tomato and Pepper Seed
257/635	*Bacterial Speck of Tomato
257/635	*Black Heart and Jelly End-Rot of Potatoes
257/635	*Blackleg of Potatoes
257/635	*Late Blight of Potatoes
257/635	Virus Diseases of Tomato and Pepper
257/690	*Tomato Fruit Disorders
257/745	Reducing Mechanical Injury in Potato Handling
258/13	*Baby Carrot Production
258/13	Commercial Parsnip Production in Ontario
258/13	Garlic
258/13	Garlic Production
258/13	*Horseradish
258/20	Rutabagas
258/20	Sweet Potatoes
258/55	*Onion Drying
258/605	Storage of Carrots
258/64	Storage Rutabagas
258/605	Carrot Insects
258/605	*Onion Maggot Control on Dry Onions
258/628	*Bulb and Stem Nematode in Onions
258/635	Field Diseases of Onions
258/635	Onion Neck Rot
258/635	Phoma Canker of Parsnip
258/635	Turnip Mosaic Virus (Tumv) of Rutabaga

Factsheets (Continued)

258/635	*Virus Disease of Rutabagas (Turnips)
258/635	Weather-Timed Sprays for Carrot Blight Control
258/690	Brown Heart in Rutabaga
258/732	Artificial Curing of Onions
291/635	Bacterial Canker of Tomato
296/510	*Soilless Mixes
512	*Management of Organic Soils
534	*Soil Acidity and Liming
553	*Maintenance of the Drainage System
555	Drainage Benefits
562	*Irrigation Water Supply
572	Soil Erosion — Causes and Effects
573	Grassed Waterways
606	*Soil Fumigants
607	*Pesticide Drift
607	Storing Pesticides on the Farm
607	Guide to Handling and Applying Herbicide to Protect Water Supplies and Reduce Personal Exposure
607	Management of Pesticides on the Farm
607	Pesticide Container Rinsing
607	Pesticide Contamination of Farm Water Supplies
607	Protective Clothing When Using Horticultural Pesticides in Greenhouses
607	Protective Clothing When Using Pesticides Outdoors
607	Reducing Pesticide Drift and Crop Damage
610	Slugs
616	Honeybees for Pollination of Crops
628	Nematode Control — Guidelines
628	Soil and Root Sampling for Nematode Analysis
675	*Earwigs
675	Sap Beetles on Raspberries, Tomatoes, Corn
707	*Homemade Hygrometers
707	*Measuring Relative Humidity (RH)

AGRICULTURE CANADA PUBLICATIONS

868	Manures and Compost
1058	Potatoes
1083	Soil Erosion by Water
1158	Growing Savory Herbs
1266	Soil Erosion by Wind
1337	How to Build a Plastic Crop Shelter or Greenhouse
1355	Growing Rutabagas
1479	Tomato Diseases
1482	Field Sprayers
1492	Diseases and Pests of Potatoes
1508	Bulk Potato Storage
1558	Growing Garden Tomatoes
1559	Growing Garden Potatoes
1664	Rhubarb Culture
1681	Composting
1684	Cucumber Diseases

**Indicates publication out-of-print although County offices may have a supply on hand.*

ABBREVIATIONS

EC	= emulsifiable concentrate	g	= gram
WP	= wettable powder	m	= metre
F	= flowable	cm	= centimetre
E	= emulsion	ha	= hectare
SC	= spray concentrate	mL	= millilitre
SP	= soluble powder	t	= tonne
G	= granules or granular	kg	= kilogram
°C	= degrees Celsius	km	= kilometre
AP	= agricultural powder	mm	= millimetre
W	= wettable (powder)	L	= litre
L	= liquid	hL	= hectolitre
LC	= liquid concentrate	kPa	= kilopascal

METRIC INFORMATION

THE METRIC SYSTEM

Linear Measures (length)

10 millimetres (mm) = 1 centimetre (cm)
100 centimetres (cm) = 1 metre (m)
1000 metres = 1 kilometre (km)

Square Measures (area)

100 m x 100 m = 10,000 m^2 = hectare (ha)
100 ha = 1 square kilometre (km^2)

Cubic Measures (volume)

Dry Measure

1000 cubic millimetres (mm^3) = 1 cubic metre (m^3)
1,000,000 cm^3 = 1 cubic metre (m^3)

Liquid Measure

1000 millilitres (mL) = 1 litre (L)
100 L = 1 hectolitre (hL)

Weight — Volume Equivalents (for water)

(1.00 kg) 1000 grams = 1 litre (1.00 L)
(0.50 kg) 500 g = 500 mL (0.50 L)
(0.10 kg) 100 g = 100 mL (0.10 L)
(0.01 kg) 10 g = 10 mL (0.01 L)
(0.001 kg) 1 g = 1 mL (0.001 L)

Weight Measures

1000 milligrams (mg) = 1 gram (g)
1000 g = 1 kilogram (kg)
1000 kg = 1 tonne (t)
1 mg/kg = 1 part per million (ppm)

Dry — Liquid Equivalents

1 cm^3 = mL
1 m^3 = 1000L

APPLICATION-RATE CONVERSIONS

(approximate)

Metric to Imperial (Approximate)

litres per hectare x 0.09	=	gallons per acre
litres per hectare x 0.36	=	quarts per acre
litres per hectare x 0.71	=	pints per acre
millilitres per hectare x 0.015	=	fluid ounces per acre
grams per hectare x 0.015	=	ounces per acre
kilograms per hectare x 0.89	=	pounds per acre
tonnes per hectare x 0.45	=	tons per acre

Imperial to Metric (Approximate)

gallons per acre x 11.23	=	litres per hectare (L/ha)
quarts per acre x 2.8	=	litres per hectare (L/ha)
pints per acre x 1.4	=	litres per hectare (L/ha)
fluid ounces per acre x 70	=	millilitres per hectare (mL/ha)
tons per acre x 2.24	=	tonnes per hectare (t/ha)
pounds per acre x 1.12	=	kilograms per hectare (kg/ha)
ounces per acre x 70	=	grams per hectare (g/ha)

Dry-Weight Equivalents

Grams or Kilograms per Hectare		Approximate Ounces or Pounds per Acre
100 grams	=	1½ ounces
200 grams	=	3 ounces
300 grams	=	4¼ ounces
500 grams	=	7 ounces
700 grams	=	10 ounces
1.10 kilograms	=	1 pound
1.50 kilograms	=	1¼ pounds
2.00 kilograms	=	1¾ pounds
2.50 kilograms	=	2¼ pounds
3.25 kilograms	=	3 pounds
4.00 kilograms	=	3½ pounds
5.00 kilograms	=	4½ pounds
6.00 kilograms	=	5¼ pounds
7.50 kilograms	=	6¾ pounds
9.00 kilograms	=	8 pounds
11.00 kilograms	=	10 pounds
13.00 kilograms	=	11½ pounds
15.00 kilograms	=	13½ pounds

Liquid Equivalents

Litres/Hectare		Approximate Gallons/Acre
50	=	5
100	=	10
150	=	15
200	=	20
250	=	25
300	=	30

CONVERSION TABLE — METRIC TO IMPERIAL

(approximate)

Length

1 millimetre (mm)	=	0.04 inch
1 centimetre (cm)	=	0.40 inch
1 metre (m)	=	39.40 inches
1 metre (m)	=	3.28 feet
1 metre (m)	=	1.09 yards
1 kilometre	=	0.62 mile

Area

1 square centimetre (cm^2)	=	0.16 square inch
1 square metre (m^2)	=	10.77 square feet
1 square metre (m^2)	=	1.20 square yards
1 square kilometre (km^2)	=	0.39 square mile
1 hectare (ha)	=	107,636 square feet
1 hectare (ha)	=	2.5 acres

Volume (liquid)

1 millilitre (mL)	=	0.035 fluid ounce
1 litre (L)	=	1.76 pints
1 litre (L)	=	0.88 quart
1 litre (L)	=	0.22 gallon (Imperial)
1 litre (L)	=	0.26 gallon (U.S.)

Volume (dry)

1 cubic centimetre (cm^3)	=	0.061 cubic inch
1 cubic metre (m^3)	=	1.31 cubic yards
1 cubic metre (m^3)	=	35.31 cubic feet
1000 cubic metres (m^3)	=	0.81 acre-foot
1 hectolitre (hL)	=	2.8 bushels

Weight

1 gram (g)	=	0.035 ounce
1 kilogram (kg)	=	2.21 pounds
1 tonne (t)	=	1.10 short tons
1 tonne (t)	=	2205 pounds

Speed

1 metre per second	=	3.28 feet per second
1 metre per second	=	2.24 miles per hour
1 kilometre per hour	=	0.62 mile per hour

Pressure

1 kilopascal (kPa)	=	0.15 pounds/square inch

Temperature

$°F = (°C \times 9/5) + 32$

$°C = (°F-32) \times 5/9$

CONVERSION TABLE — IMPERIAL TO METRIC

(approximate)

Length

inch	=	2.54 cm
foot	=	0.30 m
yard	=	0.91 m
mile	=	1.61 km

Area

square foot	=	0.09 m^2
square yard	=	0.84 m^2
acre	=	0.40 ha

Weight

ounce	=	28.35 g
pound	=	453.6 g
ton	=	0.91 tonne

Pressure

pound per square inch	=	6.90 kPa

Volume (dry)

cubic yard	=	0.76 m^3
bushel	=	36.37 L

Volume (liquid)

fluid ounce (Imp.)	=	28.41 mL
pin (Imp.)	=	0.57 L
gallon (Imp.)	=	4.55 L
gallon (U.S.)	=	3.79 L

Temperature

$°F = (°C \times 9/5) + 32$

$°C = (°F - 32) \times 5/9$

EMERGENCY AND FIRST-AID PROCEDURE FOR PESTICIDE POISONING

Become familiar with the chemicals you are using. Keep a list of common names in case of accidents or emergencies. This information can be found on the product labels and cross-referenced in this publication.

If a pesticide has come in contact with the skin or has been spilled on clothing, remove the clothing, and wash the skin thoroughly with soap and warm water. Repeat the wash.

If a pesticide has come in contact with the eyes, rinse them with plenty of clean water for 15 minutes.

If a person suspects poisoning from exposure to a pesticide by swallowing, inhalation, or contact with skin or eyes, read the label on the pesticide container and carry out the first-aid treatment suggested.

IMMEDIATELY AFTER THE FIRST-AID TREATMENT HAS BEEN GIVEN, WRAP THE PATIENT IN A COAT OR BLANKET AND RUSH HIM TO THE NEAREST HOSPITAL. TAKE THE LIST OF CHEMICAL COMMON NAMES WITH YOU AND IDENTIFY THE ONES BEING USED. IF A PERSON IS FOUND UNCONSCIOUS OR LAPSES INTO UNCONSCIOUSNESS, CALL AN AMBULANCE IMMEDIATELY!

Emergency advice on pesticide poisoning is available by contacting the Poison Information Centres: The names and telephone numbers are listed under Emergency Calls at the front of each Bell telephone directory.

FILL IN THE FOLLOWING:

MY LOCAL POISON INFORMATION CENTRE TELEPHONE NUMBER IS: _____

POISON CONTROL CENTRES IN ONTARIO

Barrie
Royal Victoria Hospital
Dr. Raymond Alquist
Emergency Department
(705) 728-9802

Belleville
Belleville General Hospital
Dr. James E. Nelles
Emergency Department
(613) 968-5511

Brantford
Brantford General Hospital
Dr. C.H. Pickett
(519) 752-7871

Burlington
Joseph Brant Memorial Hospital
Dr. D. Raes
(416) 632-3730

Chatham
St. Joseph's Hospital
Emergency Department
(519) 352-2500

Guelph
St. Joseph's Hospital
Dr. J.J. Brown
(519) 824-2620

Kingston
Kingston General Hospital
Dr. Murray Taylor
(613) 547-2121

Kirkland Lake
Kirkland and District Hospital
Director
(705) 567-5251

Kitchener
Kitchener-Waterloo Hospital
Dr. Swan
(519) 742-3611

St. Mary's General Hospital
Dr. W.H. Friday
(519) 744-3311

London
Victoria Hospital
Emergency Department
(519) 432-5241

Ottawa
Children's Hospital
Emergency Department
(613) 521-4040

Ottawa General Hospital
Emergency Department
(613) 231-2121

Picton
Prince Edward County
Memorial Hospital
Emergency Department
(613) 476-2181

St. Catharines
St. Catharines General Hospit..
Dr. W.G. Sollich
Emergency Department
(416) 684-7271

Sarnia
Sarnia General Hospital
Dr. K.R. Singh
Emergency Department
(519) 344-3661

St. Joseph's Hospital
Emergency Department
(519) 336-6121

Sault Ste. Marie
Plummer Memorial
Public Hospital
Dr. W.J. Robertson
Emergency Department
(705) 254-5161

Simcoe
Norfolk General Hospital
Dr. K.R. McGavin
(519) 426-0750

Sudbury
Sudbury General Hospital
Dr. E.S. Lapchinski
(705) 674-3181

Thunder Bay
McKellar General Hospital
Dr. P.C. McGillivray
(807) 623-5561

Port Arthur General Hospital
Dr. Arnot R. Hawkins
(807) 344-6621

Toronto
Toronto East General and
Orthopedic Hospital
Dr. A. Kaminker
(416) 461-8272

Hospital for Sick Children
Dr. Raymond Ng
(416) 597-1500

Windsor
Hotel Dieu de St. Joseph
Dr. W. Gatfield
Emergency Department
(519) 252-3631